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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . . . L. W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

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UNIVERSITY FAULTS.

In a recent address Dr. G. Stanley Hall discussed certain changes which he deems desirable in American colleges. Dr. Hall always says something worth hearing, and talks convincingly; yet it seems to some of us that the view which he takes regarding technical education is not wholly unbiassed. He pleads for the so-called "culture" studies, and regrets the rapidly increasing popularity of "utility" studies. These distinctions seem a little forced. Any study which has an educational value—that is to say, which trains the mind and the will of the student—is valuable, no matter whether the knowledge which the man thus gains is directly useful for his future work or not. With the bare statement that more time should be given to the culture studies, and less to the utilities, during a college course, we can not assent, but this much can be said: the old proverb about keeping Jack working all day, leaving him no time for recreation, applies as well to college work and to Jack's work in after years as it does to his school days. The student who devotes all of his time to studies in his chosen profession not only can not get as much pleasure out of his course as if he took up some other studies not at all related to his professional studies, but there is danger of his becoming narrow. The same may be said of his work after graduation. He should be interested in something other than his profession. He should have some recreation—a fad if you will—which will draw him away frequently from the desk or the shop. He will find that, no matter how deeply he is interested in his work, that if he takes pleasure in something else as well, he will enjoy his work all the more and will be all the happier.

THE OPERATION OF TRANSFORMERS IN PARALLEL.

The operation of transformers in parallel is a generally accepted practice which receives but little attention to-day. Every engineer knows that this is being done satisfactorily, and he dismisses the subject merely with the statement that the transformers must be so operated. It is generally known that there are certain conditions which must be met if this practice is to be successful. It is a good thing to have transformers connected in parallel of the same type and size, as then they can be expected to share the load evenly. But when it is necessary or desirable to connect transformers of different sizes on the same distributing circuit, more care is needed in order that certain of them may not be overloaded. The generally accepted condition for success is that all the transformers shall have the same regulation.

The problem is, however, somewhat more complex than this simple requirement would seem to indicate. In fact, operation of two transformers in parallel may be compared with the operation of two generators in parallel. Not only must they be designed for the same voltages, both primary and secondary, but their internal characteristics must be similar, and the constants of the connecting leads must be considered as well. On another page of this issue Mr. R. T. MacKeen discusses, in an interesting way, this subject, and shows how the suitability of different transformers for parallel operation can be determined. He reduces the matter to a simple basis, enabling any one to reach quickly a decision, not only as to the suitability of the apparatus for parallel working, but to predict what proportion of the total load each transformer will carry. The data required are generally furnished with the transformers, but when this is not the case they can be obtained easily by simple measurements. It should be borne in mind that the data used in these determinations must be that of normal operation—that is to say, with the transformers hot, a change in temperature might make a considerable change in the characteristics, and upset one's calculations completely.

THE BURYING OF THE WIRES.

Last week announcement was made that the American Telephone and Telegraph Company, cooperating with the Bell licensee companies, is laying a conduit line from Chester, Pa., to New York city, in which a number of telephone cables will be placed. This line will supplement the overhead system and will also give further information on the operation of long buried lines. The work is exceedingly expensive, but is being done in order to avoid the interruptions due to storms which occur in some part of the country almost every winter. Overhead line construction has become more and more substantial, but it seems almost impossible to provide for the unexpected. The result is that hardly a winter passes but some point is practically isolated from the rest of the country.

Following shortly on the announcement of the telephone company, it was stated that the Western Union Telegraph Company was also preparing plans for burying some of the most important of its lines. The average reader does not realize the importance of these announcements. To place the wires of either telephone or telegraph companies underground is enormously expensive, and at the same time it adds to the difficulty of obtaining successful operation. Except for the greater immunity from damage by storms, there is little or no advantage in burying the wires where they cross country, but the greater security thus obtained is worth a large price. An all-important essential of these two methods of communication is reliability, and if this can be improved by placing the wires underground, at the same time without rendering the service poorer, a considerable expense will be warranted. In Europe, where distances are not so great, more in this direction has been done. In England, particularly, the British post office has adopted a policy of burying certain trunk lines, and at the present time has most of the larger cities connected with London in this way, thus ensuring continuity of service no matter what the weather may be. The latest statistics available regarding this work in the world were quoted in a recent address by Mr. John Gavey, on the occasion of his inauguration as president of the Institution of Electrical Engineers, of Great Britain. Mr. Gavey stated that at the end of the year 1902—the latest year for which figures were available—all systems reporting were operating 225,748 miles of underground telegraph wire and 3,433,434 miles of aerial wire. This is a good showing for the telegraph, but that of the telephone is even better, doubtless because of the preponderance of city lines. Over one-third of the wire used for telephone communication in the world is underground, there being 2,530,000 miles of underground wires. The last census report on telegraphs and telephones in this country, covering the year 1902, showed that of the total miles of telegraph wire, some 1,307,000, about 21,650 were underground. The telephone systems naturally made a better showing with 2,370,000 miles of underground wire out of a total of 4,850,000.

It seems probable that now that the work of laying underground trunk lines between a few important cities has been started that this service will be extended as rapidly as the conditions warrant. The work is not only expensive, but is troublesome, due to the great distance between cities, and the difficulty of maintaining satisfactory communication. This is more particularly true of the telephone than of the telegraph, but Dr. M. I. Pupin's invention of a loaded telephone line should aid materially in establishing satisfactory talking conditions. Probably before many years all of the larger northern cities will be safe from entire isolation by a severe storm. Further south there is less need for burying the wires.

WATER-POWER DEVELOPMENTS.

One of the interesting phases of the engineering work of the present day is the attention that is being paid to developing water powers. Every one seems to be particularly interested in this matter, and one can not take up an engineering paper, no matter to what branch of engineering it is particularly devoted, without finding a description of some interesting plant or, at least, a reference to some such undertaking. We seem at last to be appreciating these gifts of nature, and are at work on, or planning for, the development of those power sites that we know of, and are seeking for others elsewhere. These developments are of particular interest to electrical engineers, because were it not for the possibilities of electrical transmission, comparatively few of our water powers would be of any commercial value. By virtue, however, of the ease and economy of such transmission, every water power to-day has some value, except those which are most remote from any industrial centre.

Possibly one reason why every engineer is so interested in water-power plants is because each water-power site presents a particular problem of its own. There is a certain available height, a variable flow of water, and an uncertainty regarding local conditions. Each situation must be studied carefully, because, in some respects at least, it differs from any other, and the equipment, in general, can not be standardized. As regards the electrical end, there is not so much choice, since the frequency and generally the voltage are pretty well standardized; but as regards the hydraulic end of the plant, each situation generally calls for a new design.

Then there is the interest which every one feels in turning to practical use what has heretofore been allowed to go to waste. One somehow feels as though a water power is a special gift which can be turned to profitable uses without much expense; as though here is something which costs nothing, but if only developed will pay well. In a certain sense this is true, but as a general thing hydraulic plants are expensive compared with steam plants, and they are paid for in this way. On the other hand, a water power should be inexhaustible, and a coal mine must some day send up its last load. We should therefore all be interested in the preservation of our water powers in proportion as we are interested in their development as feats of engineering, and as we wish for a prosperous development of the country—that is to say, we have here certain physical advantages of which we should make the best use. Now, if these advantages are not taken care of, they will dwindle and may finally cease to be. They can be preserved for the benefit of future generations by proper protection of our forests

and watersheds. Already something has been done in this direction, but much more remains to be done. It is a matter of interest to every body, not only to every user of electricity and to every one interested in manufactures, but to the public in general. Cheap power is of vital importance, and no matter how extensive or inexhaustible our fuel supplies seem to be, it is a matter of record that fuel of all kinds is becoming more and more expensive. Water power, on the other hand, should not become more expensive as time goes on; in fact, it should become cheaper, as improved methods of development are found. The general interest in water-power development is therefore a good thing. It should be encouraged, and an effort made to educate the public in some of the larger problems relating to it.

ELECTRICAL REFRIGERATION.

Electrical refrigeration, by which is meant the driving, either automatically or under supervision, of refrigerating machines by means of an electric motor, is becoming important in minor applications of electricity. Such applications will, in general, be limited to small refrigerating plants, as, for example, for hotels and for small cold-storage rooms. They are not intended to compete with the large cold-storage houses or ice-producing plants. Probable the features of these small plants which will appeal most to those who make use of them will be the doing away with the ice box and the nuisance which that involves. This feature alone is worth a good deal. Not only is the annoyance of bringing in the ice and packing it in the box serious, but the space taken up in this way and the undesirable moisture brought so close to the cold vault, where dryness is desirable, are bad features. Another advantage secured by means of the small refrigerating plant is the control which is thus obtained of temperature. With ice, one must take what he can get and be thankful, but with the motor-driven refrigerating machine, the temperature can be kept at any desired point; in fact, the machine may be made to take care of this automatically. This is certainly a development which will be thoroughly appreciated, and which will undoubtedly be put to greater and greater use. It is hardly necessary to call attention to the fact that the part which electricity plays here is merely that of furnishing a cheap, clean, convenient and ever-ready source of power.

There are other ways in which the electric motor can be applied to household work. Electric power is now used in the most modernly equipped hotels for doing much that elsewhere is done by hand, and there is no reason why the principle should not be extended to the smaller establishment. One motor could be arranged to do a great variety of work, relieving the housekeeper of much that requires exertion and leaving her only under the need of directing its operations. An electrically operated vacuum sweeper—that is to say, one which collects the dust from the floor without stirring it up in the air—would be a boon. The same motor could run a dish-washer, drive a sewing-machine, clean the silver, polish shoes, knead the bread, drive the meat-chopper, and, in fact, do anything which can be accomplished by turning a crank. We have relieved the poor horse of some of his hardest city work. Let us now direct our attention toward relieving the poor housewife of some of her most tiring and uninteresting occupations.

AUTOMOBILES.

An encouraging sight to any one interested in transportation problems is a fine automobile such as may be seen now on the streets of a city; yet on watching a busy thoroughfare for a short time, one can not help wishing that there were more mechanically propelled vehicles and fewer of the old-fashioned horse-drawn type. It is true that the automobile is still something of a novelty. The pleasure vehicle may yet be considered a fad, which means that those who are able are spending money for developing a machine which will benefit us all. They are thus doing a public service.

But it is not this type of machine that we at present have in mind. We are thinking rather of the commercial wagon—the mechanically propelled truck. Many advantages might be urged for these vehicles in city use—in fact, so many advantages were urged so vigorously a couple of years ago that one almost expected the horse to be driven from the city streets within a year or so. Of course, time is required to develop any new machine. Almost invariably the conditions of operation are different from those imagined. The weak part of the machine must be found out and the unnecessarily heavy parts must be identified. The successful type must come by a process of evolution, which, of course, requires time. One can not say that the development of the automobile has been retarded—indeed, it seems to have made good progress. Yet the machines are not so common on the streets to-day that they pass unnoticed. It is possible that the placing upon the market of a greatly improved storage battery would accelerate the introduction of automobiles. If so, it is to be hoped that this consummation may not be delayed much longer. To the man of the street, who merely sees the trucks in motion, and who does not know what it costs to operate them and keep them in serviceable condition, there seems to be a large number of successful types and he wonders why there are so many horse-drawn vehicles.

We are doing much—or attempting to do much—toward keeping the city air clean, although this naturally renews itself; but as regards city streets, we do nothing toward preventing their soiling. Certain of the larger cities have organized street-cleaning departments for cleaning up the mud and dirt after it has been distributed, but we do nothing toward preventing this distribution. It is a common thing to see persons scattering fruit skins or paper when they wish to be rid of them—a practice which would not be tolerated in the principal cities of Europe.

The automobile is a particularly cleanly vehicle, and its use in cities should be favored. For example, Manhattan Island is entirely surrounded by water, and on all sides of it are important cities, which act as door-mats to cleanse the wheels of vehicles and the feet of persons coming to the larger town. One might expect, therefore, that a city situated thus fortunately would have particularly clean streets, yet a large force of men is required in order that they may be kept reasonably free from dirt. If one may not burn soft coal indiscriminately, thus distributing a minutiae of dirt in the air, why should another be free to soil the streets as he pleases? Either restriction in one case is unjust, or there is need for more regard for the public streets. Toward keeping the streets clean the use of automobiles is helping.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER X.

Other Properties of the Radiations.

We have already studied a number of the properties of the several kinds of radiations, and have compared the one with the other. We shall now take up certain special properties of the several kinds of radiations sent out by radium.

THE SELF-LUMINOSITY OF RADIUM COMPOUNDS.

While the comparatively pure radium salts give out only a little light, radium salts which contain a large amount of barium are strongly self-luminous. This fact was observed by the Curies. The dehydrated, dry halogen compounds of radium are especially self-luminous. While the self-luminosity can not be perceived in ordinary daylight, it can be seen by gaslight. The light is sufficiently intense to enable one to read in a dark room. The self-luminosity comes from the entire mass of the radium salt, and not simply from the surface. In the presence of moist air the salt loses a large amount of its self-luminosity, but this is again regained on drying the preparation. The self-luminosity persists for a long time. Specimens preserved for years in the dark still continue to be self-luminous. Mme. Curie points out that the color of the light emitted from strongly radioactive preparations changes with time. It becomes more violet and decreases in intensity. The original intensity and color are regained by recrystallizing the salt from water. The luminosity of the radium salt is apparently independent of temperature. Solutions of radium salts are slightly self-luminous. The crystals in such a solution are more strongly self-luminous than the solution, and can be seen by the light which they emit.

Mme. Curie points out that *radium is the only substance known that is self-luminous.* It will be remembered that radium is the only substance known that has the power to *charge itself electrically.*

FLUORESCENCE PRODUCED BY RADIUM SALTS.

That salts of radium are capable of producing fluorescence in certain substances has already been mentioned. This was first discovered by the Curies. It was subsequently studied by others, and especially by Becquerel. The radiations were allowed to fall on a number of substances in the form of powder, which were found to be fluorescent or phosphorescent. Thus, the diamond, ruby, the sulphide of calcium, zinc sulphide, barium platinocyanide, and a number of other substances have been tested.

It may be said in general that those substances that fluoresce in ultra-violet light, are rendered fluorescent by radium. The action of the radium is, however, not the same as that of the X-ray in producing fluorescence. Certain substances fluoresce when exposed to the X-ray, that do not show any fluorescence in the presence of radium, and *vice versa.*

Paper, cotton, as well as certain varietes of glass fluoresce in the presence of radium. This is especially true of Thuringian glass. Under the action of radium the glass that fluoresces becomes colored violet to brown. When the glass has become colored its power to fluoresce is diminished. If the glass which has become colored and has lost its power to fluoresce is heated, the color is lost and the fluorescing power is again regained. Barium platinocyanide is the best substance with which to study the fluorescent action of radium salts. It makes the most satisfactory fluoroscope, especially for the β and γ rays. It flouresces when two metres from active radium.

Zinc sulphide, as we have seen, is also rendered fluorescent by the radium rays. It is especially sensitive to the action of the α rays, where it shows the characteristic scintillations in the spinthariscope. The β rays also produce fluorescence in zinc sulphide. It has already been mentioned that the diamond becomes fluorescent in the presence of radium, and can thus be distinguished from the imitation.

While all three kinds of rays produce fluorescence, the α rays, on the whole, are the most active. This can be seen by interposing between the radium and the fluorescent screen a thin piece of metal foil or of paper which will cut off the α particles. The β and γ rays can also produce fluorescence, especially in screens of barium platinocyanide. Their power to produce fluorescence is, however, much feebler than that possessed by the α particles.

RADIUM INCREASES THE CONDUCTIVITY OF DIELECTRICS.

The property of radium to ionize a gas and render it a conductor has already been repeatedly mentioned. A good qualitative method of demonstrating this power is the following: Take an induction coil and place the discharging points just so far apart that a spark will cease to pass. Then place a glass tube containing a few milligrammes of an active radium salt between the two points. The discharge will take place at once. This is due to the ionization of the air between the terminals by the radiations from the radium. In the above case most of the ionization is produced by the γ rays, since most of the α and β rays are cut off by the glass. If the radium salt were placed in an open vessel so as to secure the ionizing effect of the strongly ionizing α rays, the conductivity of the gas would be still more increased.

The *conductivity* of a number of *liquid non-conductors* is very considerably increased by exposing them to the radium radiations. Thus, a number of our best liquid insulators acquire a measurable conductivity under the influence of the radiations from radium. This applies to carbon disulphide, petroleum, ether, liquid air, vaseline, oil, etc.

It would seem that this ionization in liquids was produced mainly by the γ radiations, since similar results are obtained when the liquids are exposed to X-rays, with which, it will be remembered, the γ rays are closely allied. Similar results have been obtained with certain solid dielectrics. Thus, paraffine exposed to the radiations from radium acquires some conductivity. The ionization produced in the paraffine, as well as in the liquid non-conductors, is probably due mainly to the more penetrating rays from radium.

CHEMICAL EFFECTS PRODUCED BY THE RADIOACTIVE SUBSTANCES.

The crystalline halogen salts of the alkalies—the chlorides, bromides, etc., are colored by radium radiations as by cathode rays. The Curies found that glass and porcelain became colored when exposed to radium. A violet or brown color appears in the glass, which persists after the removal of the radium. Glass which has been exposed for a considerable time to the action of radium becomes darkened. This is true of all glasses, whether lead is present or not.

Mme. Curie subjected a number of glasses of known, but widely different composition, to the action of the radium radiations, and concluded that the coloration was due to the presence of the alkali metal in the glass. Salts of the alkali metals themselves showed more vivid coloration, and a greater variety of colors than the different glasses that were studied by Mme. Curie.

The most probable theory as to the cause of the coloration in glass, is that the radia-

tions from radium liberate the alkali metals, which then form a solid solution in the glass.

Radium transforms oxygen into ozone, which can be detected by its odor. This is due to the α and β rays, since, when these are cut off no ozone is produced. To understand what this transformation really means, we must ask the question what is the real difference between oxygen and ozone? The older text-books state that the difference in the properties of oxygen and ozone is to be referred to the fact that oxygen contains two atoms in the molecule, and ozone three. It is obvious that this explains nothing, except the difference between the mass of the atom of oxygen and the mass of the atom of ozone. The chemical and physical properties, in general, of substances cannot be explained on any material bases. To gain any rational conception of them we must take into account the energy relations and conditions that exist in the substance in question.

It is a simple matter to prove that the real difference between the properties of oxygen and ozone is due to the *different amounts of intrinsic energy* contained in their molecules. If we burn carbon in oxygen or in ozone, the same end product —carbon dioxide is obtained. If oxygen and ozone contain different amounts of intrinsic energy, there will be different amounts of heat liberated when the same amounts of carbon are burned in the two gases; since the amount of heat liberated in any case is the thermal expression of the difference between the intrinsic energy of the system before a reaction has taken place, and after the reaction is completed.

If we burn a given weight of carbon in ozone, *more heat is liberated* than when we burn the same weight of carbon in oxygen. Since the same amounts of carbon dioxide are formed in the two cases, we must conclude that *ozone contains more intrinsic energy than oxygen,* and any differences in the properties of these two allotropic modifications of the same element, are to be referred to the different amounts of intrinsic energy contained in their molecules. Radium, then, adds energy to oxygen, transforming it into ozone, and this is accomplished mainly by the α and β rays. This is in keeping with our knowledge of the radiations given off from radium, since most of the energy is contained in the α particles. According to Becquerel, radium radiations can also transform white phosphorus into red.

Radium compounds undergo changes themselves under their own radiations. When the method of separating radium from pitchblende was under discussion, it was pointed out that crystals of radium chloride with which barium chloride was mixed, while colorless when first formed, became quickly colored. The color is lost by recrystallizing the salt. The coloration produced by the radium salts extends more deeply into the substance than that caused by the cathode rays.

It has already been mentioned that the radiations from radium affect a photographic plate. This is, of course, due to a chemical action on the silver salt on the photographic plate. Polonium acts on a photographic plate only when the plate is brought very near to the substance. This is due to the fact that polonium gives out only α rays, which have weak photographic action; and further, are largely absorbed by a layer of air, even a few centimetres in thickness.

Radium, however, acts at much greater distances on a photographic plate. It produces a marked impression at a distance of several feet, even when the radium is enclosed in a glass tube, which cuts off all of the α rays, and some of the β. We have seen that it is the γ rays that are especially active photographically. It has been found that the best *radiographs* are produced by the γ rays alone.

PHYSIOLOGICAL ACTION OF THE RADIUM RADIATIONS.

Fairly active radium is capable of producing burns or wounds when brought near the skin, that are both painful and slow to heal. The skin is first inflamed and reddened, and may actually be blistered if exposed for a sufficient length of time close to an active preparation of radium.

The action of the radiations from radium upon certain diseases of the skin such as Lupus has been tested, and apparently has yielded good results in the hands of the dermatologist. It has also been claimed to have produced wholesome effects upon cancerous tissue, especially in the early stages. Whether it is really capable of curing this disease remains to be seen. It is certainly true that the radiations from radium are more penetrating than ultra-violet light or X-rays, which have been shown to have certain curative properties. They can, therefore, penetrate more deeply into the tissue, and might give better results.

An interesting physiological experiment has been described by Gietel, and carefully studied by Himstedt and Nagel. If a preparation of radium is brought near the closed eye in a dark room, a sensation of light is produced. This is due to the fluorescence produced within the eye itself by the radium, the lens and retina being strongly fluorescent under the action of the β and γ rays. This sensation is experienced even by the blind, if the retina is intact. The β and γ rays are the active agents in producing this sensation.

Aschkinass and Caspari have shown that the radiations from radium also diminish the activity of certain bacteria.

The physiological action of radium is due mainly to the α and β rays. These are cut off by placing the radium salt in a metal box—especially in one of lead. This precaution should always be taken when active preparations of radium are being used.

The Chicago Electrical Show.

Space in the Chicago electrical show, under the direction of the Electrical Trades Exposition Company, to be held in the Coliseum, Chicago, January 15 to 27, is being rapidly taken. Nearly one-half of the available 38,000 square feet, it is announced, has been assigned. The revised list of firms contracting for space to date is reported as follows:

American Steel and Wire Company, Monarch Electric and Wire Company, Guarantee Electric Company, J. L. Schureman Company, Roth Bros. & Company, Swedish-American Telephone Company, Reynolds-Dull Flasher Company, American Electric Company, Haller Machine Company, Electric Appliance Company, I. A. Bennett, Osburn Flexible Conduit Company, Electric Storage Battery Company, Chicago Edison Company, Electro-Dynamic Company, Federal Electric Company, Overbaugh & Ayers Manufacturing Company, Peru Electric Manufacturing Company, H. T. Paiste Company, Sam. J. Gorman & Company, C. H. Thordarson, Central Electric Company, Miller Anchor Company, Crocker-Wheeler Company, Universal Electric Storage Battery Company, Mark Manufacturing Company, H. E. Cobb, Geo. W. Conover, Oliver Manufacturing Company, Western Electric Company, Sprague Electric Company, Vesta Accumulator Company, J. Lang Electric Company, Crane Company, Krantz Manufacturing Company, Chicago Battery Company, Chicago Pneumatic Tool Company, Safety Armorite Conduit Company, Safety Insulated Wire and Cable Company, General Electric Company, Fort Wayne Electric Works, W. H. Schott, Vim Company, Telephony Publishing Company, Automatic Electric Company.

The competition among the art institute students for the prizes offered for the three best posters suitable for a show of this kind has developed some striking results.

BOOK REVIEWS.

"Fowler's Mechanical Engineer's Pocket Book." 1906 edition. Edited by William H. Fowler. Manchester, England. Scientific Publishing Company. 516 pages. 4 by 6 inches. Diagrams. Price: leatherette with red edges, 1s. 6d.; post free, 1s. 9d. Leather with gilt edges, 2s. 6d.; post free, 2s. 9d.

This convenient year book, which is brought up to date annually, contains a good deal of useful information, in convenient form, for the mechanical engineer and machinist. In addition to the usual tables, which are essential to any one using the English systems of weights and measures, brief descriptions of fundamental physical laws are given, and descriptions of machinery. Instructions for adjusting machines and estimating their performance are included, as well as tables of standard dimensions for machine parts, and useful information on other subjects which should be found in a book of this character.

"La Séparation Electromagnétique et Electrostatique des Minerals. Désiré Korda. Paris. L'Eclairage Electrique. Paper. 220 pages. 6½ by 10 inches. Illustrated. Price, 6 francs.

In this book the author gives his experience in the use of electromagnetic separators, and he does more: he describes the general use of such apparatus, whether it be of the electrostatic or electromagnetic type. He discusses the theory of its operation, and describes the various machines which have been devised for this purpose. He also takes up, somewhat in detail, the design of electromagnetic separators, going into the physical principles as far as is necessary, and giving the requisite magnetic data. Following this part of the work, descriptions are given of about a dozen installations of magnetic separators in Europe and America. The book concludes with two chapters, one dealing with the preparatory work which must be done on the material to be treated before it is passed through the separator, and the other on paramagnetic substances. The book forms a complete treatise on the use of ore concentrators of the types mentioned.

"Fowler's Electrical Engineer's Year Book and Directory of Light, Power and Traction Stations." 1906 edition. Manchester, England. Scientific Publishing Company. 643 pages. 4 by 6 inches. Tables and diagrams. Price: leatherette, 1s. 6d.; post free, 1s. 9d. Superior binding, gilt edges, 2s. 6d.; post free, 2s. 9d.

This is a handy little book for the electrical engineer. It contains the usual tables of electrical constants and formulæ of electrical quantities. Methods of measuring electrical values and the use of certain instruments are described in a satisfactory way. The physical laws necessary for understanding electrical apparatus are briefly discussed, and their application to practical devices is shown. Different types of electrical machines are described, and the methods for adjusting and testing them. The present book has been brought up to date by the addition of a section dealing with the designing of alternators, and another on the subject of steam turbines and turbo-generators. Some information is given regarding the power and cost of electrical distribution, which will be useful to British users, as should also the list of power stations in London and the provinces which is appended. The latter gives, in complete tabular form, a summary of the equipment of each station.

"Principles of Electric Power for Mechanical Engineers." A. H. Bate. New York. Spon & Chamberlain. Cloth. 204 pages. 5 by 7½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $2.

Mr. Bate has endeavored here to discuss, in a simple and clear way, the principles of electrical machinery, and to show how they are applied in practice and the machines themselves adapted to practical conditions. He has succeeded in discussing the subject in a clear, understandable manner. He does not attempt to explain why electric currents and magnets behave as they do, nor what electricity is, but devotes his entire efforts to showing what they do, and how the machine works. The title of the book is, perhaps, slightly misleading, for in this country, at least, a mechanical engineer is expected to have a fair grasp of physics and to know something about fundamental electrical laws. To one who has this knowledge, the method of treatment would appear, perhaps, too elementary, but to the machinist, or the man who has not had the advantage of several years' instruction in physics, Mr. Bate's method will appeal. He avoids all but the simplest mathematical processes, and treats the subject so that it is easy to read. He starts first by describing the actions of magnets and currents, and thus develops a simple two-part, one-coil motor. From this he shows how a multiplication of coils improves the operation of the machine, and thus develops the motor as it stands to-day. The method of dealing with magnetic principles is simple, the hydraulic analogy and the idea of a leaky medium being employed, which, perhaps, for the purposes of this book, is the best way. From a description of the principles of construction the author passes to the details, but does not waste much time here. He discusses more fully the methods of motor control, showing how constant speed and variable speed are obtained with machines of different types. Distributing systems are dealt with in a short chapter, and the proper methods of installation so as to meet the requirements of the British Board of Trade are described. The cost and advantages of electric power are referred to briefly, and a table is appended, giving about 160 examples of the requirements for various kinds of machinery. With a book as elementary as this, the author can not carry his readers very far, nor do more than take up the elementary considerations; but so far as it goes, it is well prepared and covers the ground satisfactorily.

Death of Charles Cuttriss.

The announcement of the tragic death of Charles Cuttriss, chief electrician of the Commercial Cable Company, will bring great sorrow to a wide host of acquaintances and friends. Mr. Cuttriss had been very ill for some time, suffering from malarial fever, and quite recently his illness took such a severe turn that he was confined to his apartments at 2299 Seventh avenue, New York city. It is understood that Mr. Cuttriss attempted to make ready to keep a business engagement down-town on the afternoon of Saturday, November 18. He was unable to rise, however, and his devoted wife hastened to call a physician for consultation. It is thought that during a moment of mental aberration, due to absolute despondency, Mr. Cuttriss was prompted to fire the shot which so tragically ended his life. Mr. Cuttriss was for many years a leading figure in the development of the Commercial Cable Company. He took a very prominent part in the laying of the new Pacific cables, and stood very high in the esteem of the company and his associates. He was admired and respected for many genial and attractive qualities.

Mr. Charles Cuttriss was born at Bedford, England, and was fifty-six years old. He was a graduate of the University of Glasgow, Scotland, and a pupil of Lord Kelvin. He joined the French-Atlantic Cable Company in 1869, and remained at Duxbury, Mass., until 1884. He was connected with the early experiments of Lord Kelvin's siphon recorder, in which he introduced several improvements, one of which was the electromagnetic vibrator. He devised an arrangement for neutralizing earth currents on cables, and invented a system of automatic transmission which has proved most successful; also an automatic fire-alarm, which gave warning on the rising of the temperature of a room, and also of the escape of gas. He was an expert mechanician. In 1884 he joined the Commercial Cable Company's service as its chief electrician. He leaves a widow and four children. His remains were interred at Duxbury, Mass.

Les Clées-Yverdon Hydraulic Plant.

By C. L. Durand.

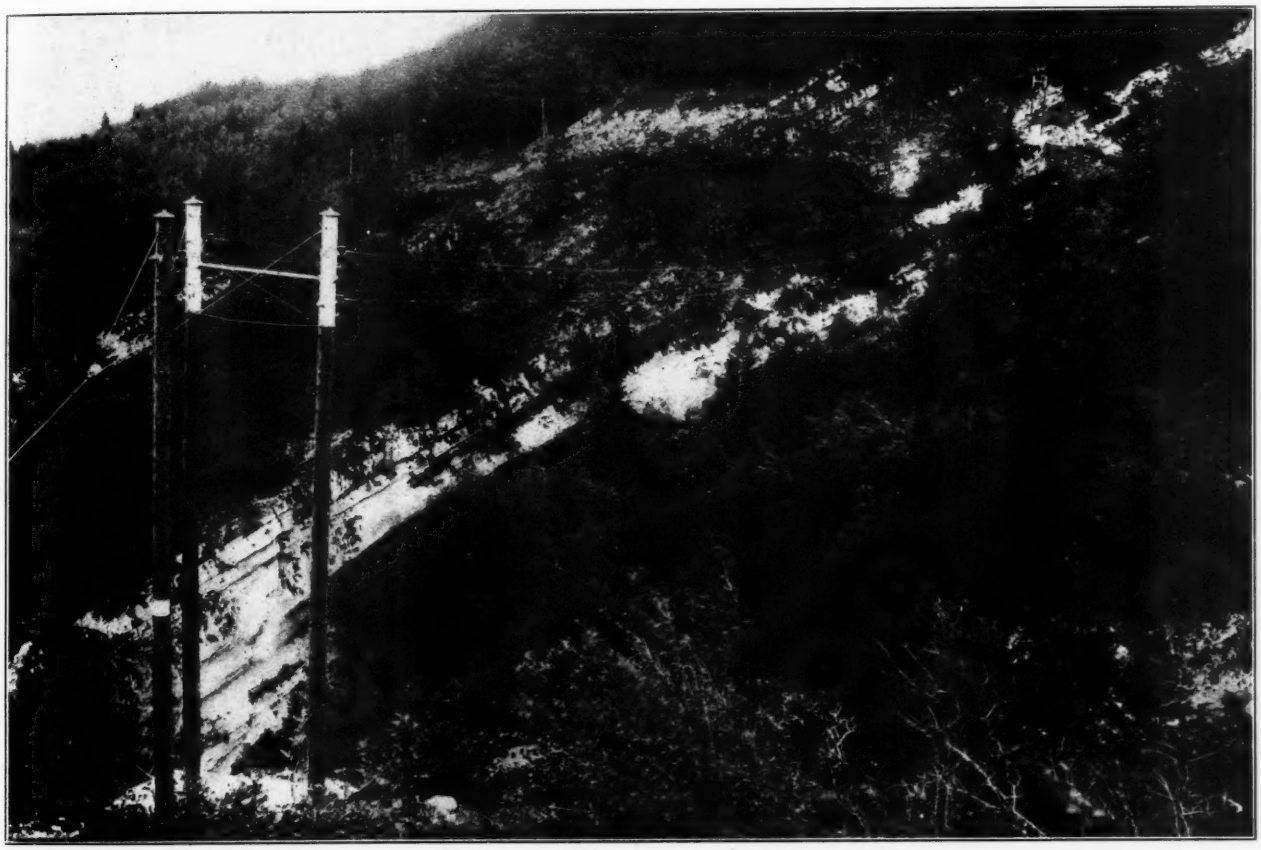
AMONG the numerous hydraulic stations which have been erected in Switzerland for supplying electric energy over a wide extent of territory, none is more worthy of interest than the Les Clées-Yverdon plant, seeing that at the present time it is one of the most important in the country, owing to the flourishing industrial condition of the region which it supplies and also to the diversity of the application of electric power.

Switzerland is one of the countries where small industries of different kinds have become greatly developed. As an instance of this we may remark the industries in the two villages of Sainte Croix and Auberson, which are situated in the high valley of the Jura at an altitude of 3,200 feet above the sea level. These localities are widely known for the manufacture of music-boxes, and this is essentially a domestic industry, like many others which are carried on in the Jura region. But the high price of coal and consequently of motive power, threatened to prevent the small industry from developing and to centralize the work in a certain number of large factories, where it could be carried on more cheaply. The introduction of electric power came just at the right moment to combat this tendency and to prevent a large number of persons from being thrown out of employment. The first condition was to find a source of power at a low cost, and in the present case the falls of the Orbe river, a rapid mountain stream, proved quite sufficient to supply a large amount of power throughout the region.

The stream rises in the lake of Joux, first running in a subterranean course, then proceeding through a narrow valley and flowing into the lake of Neuchatel. The Joux lake forms a large reservoir and serves to keep the supply of water constant. The concession for the hydraulic plant was awarded by the government to the Les Clées company, on condition that the power should be supplied to the surrounding region at a low rate. This condition has been carried out, and we find that electric power has driven all its competitors out of the field, for at present all the steam engines, gas and petrol motors have disappeared from the industrial centres of Yverdon, Baulmes, Grandson, Sainte Croix and all the other localities which the electric plant supplies.

The large repair shops of the Jura-Simplon Railroad at Yverdon are now using electric motors, as well as all the machine shops, brickworks, foundries and wood-working factories throughout the region. Besides, the possibility of securing a cheap motive power led to the establishment of a large cement factory at Baulmes, which alone uses some 200 horse-power. It is interesting also to observe the numerous applications of electric motors in all the branches of the small industries and their introduction into the family workshops which form one of the features of the Swiss region. This extension no doubt comes from the fact that the electric motors can be easily adapted to operate all kinds of machines.

In order to operate a system of this kind under the best conditions of cheapness and security, the company decided upon the three-phase current with a common primary circuit for the lighting and



LONG SPAN ON LES CLÉES-YVERDON HIGH-TENSION TRANSMISSION LINE OVER A RAVINE.

power, and a secondary circuit which is partly in common and partly separate for the two. This solution was proposed by the Oerlikon Company, which was charged with the electric outfit of the plant, and it proved quite possible to carry out, owing to the use of three-phase motors provided with starting resistances, and thus the motors have but little effect upon the lighting circuits.

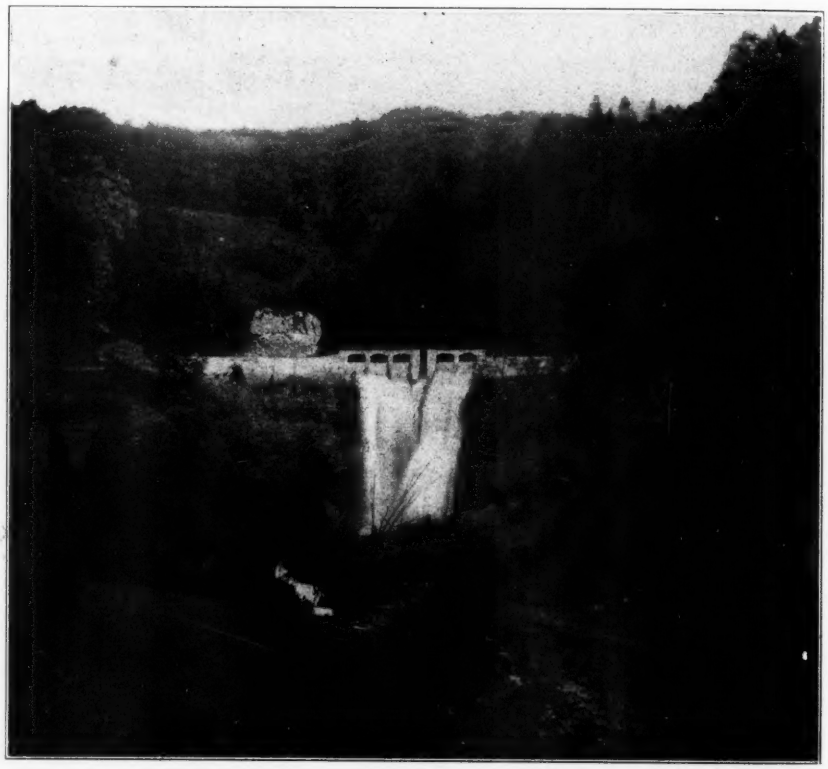
One of the engravings shows the hydraulic work which has been carried out upon the Orbe river. A dam has been erected here at a point somewhat to the south of the village of Ballaigues. A masonry construction is used entirely in the dam. From the basin, which is formed above the dam, the water is led down to the turbine station, following along the slope of the mountain, partly in a tunnel and partly in a vaulted canal. The total length of the intake canal is 3,600 metres. It is provided with ten openings along its course to allow of cleaning it out, and an overflow has been established at the end of the canal. At a point above the turbine house a penstock of sheet steel, 1.2 metres in diameter, leads down to the machines. The basin which lies above the dam is at an altitude of 619.5 metres, while the station lies at an altitude of 571 metres, thus giving a total head of water of 48.5 metres. After deducting for friction losses, there remains an effective head of water equal to forty-five metres. The Les Clées plant is laid out for a flow of water corresponding to four cubic metres per second, making some 2,400 horse-power for the present fall, or a net figure of 1,800 horse-power on the turbine shafts.

The freshets which occurred in 1899 made it necessary to carry on some further work on the hydraulic construction of the plant. During that year there was an exceptional high water, and on February 14 the turbines were flooded and the dynamos were partially submerged. During this time it was the dam which suffered most, and it was partly destroyed and had to be reconstructed. In this case the foundations were replaced by a bed of large rocks covered with an eighty-centimetre layer of concrete having a series of I-beams sunk in it. To prevent the flooding of the dynamo building, a large overflow gate was provided in the main canal, by which the water could be sent directly into the Orbe by means of a second canal. Since this construction was carried out there has been no trouble in the working of the plant.

The hydraulic station containing the turbines and dynamos has been established on the right bank of the Orbe, at a point near the bridge which leads to the village of Les Clées. The soil at this point is formed of marl for the most part, so that in order to give the proper security for the foundations the whole surface which was to be covered by the buildings had to be prepared in the first place by a layer of concrete some sixty centimetres thick. This in turn was strengthened by a series of I-beams twenty centimetres in height. The beams are disposed in two horizontal layers placed one above the other; the beams of the upper layer are laid across the lower set at right angles to them. The foundation which is thus constructed was found in practice to be sufficiently solid, as when the building was placed upon it it only sunk about four centimetres, and this was uniform throughout.

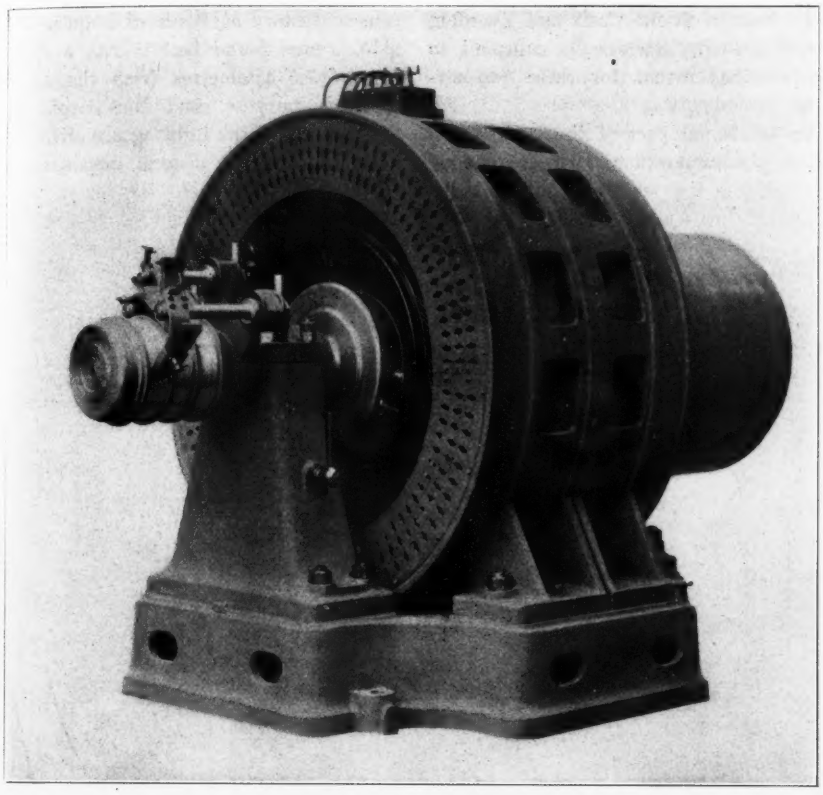
One of the engravings gives a view of the main dynamo room, showing the turbine groups which have now been put in place. The main hall measures twenty-six metres long and ten metres wide. It is laid out to receive six direct-coupled turbine groups of 300 horse-power each, having alternators of the horizontal shaft pattern. The dynamo room is provided with a five-ton crane for handling the machines. A separate room at one end of the main hall contains the switchboard. At first the switchboard was designed to take care of four alternators and the exciter circuits, but since then it has been enlarged in order to handle the new groups which have been placed in the station. At the other end of the building is a second annex which contains the quarters for the personnel of the station.

The turbines have been furnished by the Swiss firm of Piccard, Pictet et Cie, of Genoa, which has supplied a large number of the hydraulic plants in this region. As the turbines have a horizontal shaft, it is necessary to place them at several metres above the level of the offtake canal, according to the usual practice, so as to avoid all danger of flooding the machines. It was desired to lose as little of the fall between the turbines and the lower water level as possible, and for this purpose the constructors decided to use a draft tube of the Jonval pattern, which descends from the turbine and has its mouth a few centimetres below the water level. This tube is always filled with water, and owing to its weight it gives an aspirating effect upon the wheel, so that the part of the fall which lies under the turbine is utilized just as if the latter had been placed at the lowest point of the fall. For these reasons the turbines were built on the centrifugal horizontal shaft and aspiration type by the Piccard firm. This form of wheel has the advantage of working with a high efficiency in spite of the variations in the

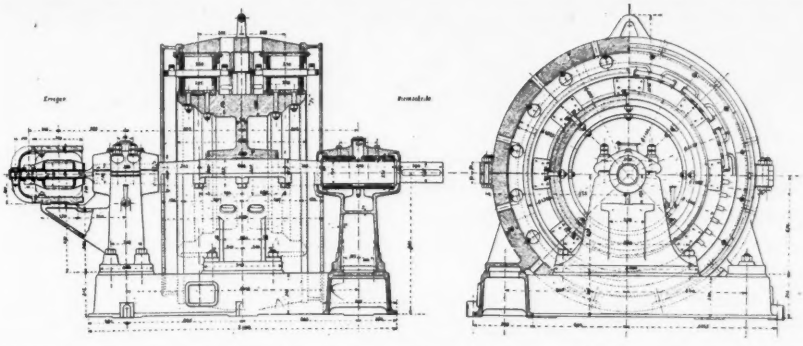


DAM ON THE ORBE RIVER FURNISHING THE HEAD FOR THE LES CLÉES-YVERDON HYDROELECTRIC STATION.

height of the fall. Between the directing vanes and the running wheel of the turbine is placed a device which serves to regulate the flow of water, in the shape of a cylindrical ring working between the distributor and the revolving wheel of the turbine, but is so designed that it does not press upon either the fixed or the movable wheel. The regulation of the water supply can be obtained with this device either by hand or automatically, thus adjusting the water delivery to the revolving wheel by the ring which acts as a revolving shutter or cut-off. In practice a hydraulic motor is generally used to control the movement of the ring, and the motor, consisting of two opposed hydraulic pistons which work the device back and forth, is operated from the main shaft of the turbine. A centrifugal ball-governor is used to control the speed, and in actual operation the number of revolutions is kept very close to the normal even should the load vary considerably. In the Les Clées plant an improved form of hydraulic motor has been employed. It is based upon the same general principles as the type which is generally used in the European stations, but it has the advantage of working perfectly even when the water is muddy and the pressure is low, which is not always the case with the ordinary hydraulic motor.



THREE-PHASE INDUCTION MOTOR, SHOWING COLLECTING RINGS AND LEVER FOR SHIFTING BRUSHES OFF THE RINGS AFTER STARTING.



SECTIONAL DRAWING, 300-HORSE-POWER ALTERNATOR, LES CLÉES-YVERDON POWER PLANT.

The turbines are connected to the alternators by a flexible shaft-coupling device on the Zoddel system, formed of two discs mounted one upon the turbine shaft and the other opposite to it on the alternator shaft. The two discs are connected together by an endless leather belt. The elasticity of this form of coupling allows a slight displacement of the axes of the dynamo and the turbine without preventing the dynamo from working regularly, and the transmission of the power from the turbine takes place under the normal conditions. This system of coupling serves at the same time as an insulation between the turbine and the alternator, so that the latter may be entirely insulated from the ground. This is an important point in stations of this kind, which are exposed to atmospheric influences to a great degree.

The alternators, which will be observed in the general view of the dynamo room and also in the plan view of the building, have been constructed for the present plant by the Oerlikon Company, of Zurich. The station contains six turbine and dynamo sets which are all of the same capacity, or 300 horse-power. The alternators are of the three-phase type, and deliver a current of 5,200 volts at a frequency of fifty cycles. The phases of these machines are connected on the star system. The alternators of the Les Clées plant are built on the inductor type. The armature is formed of a cylindrical casting made in two pieces and bolted together, which forms the main body of the machine, and carries on the inner side a pair of rings built up of laminated iron. Each of the laminated rings is provided with forty-two slots in which are lodged twenty-one coils. Each of the armature coils contains thirty-two turns of copper wire. Between the two armature rings is placed the inductor or field coil, which is made up of 480 turns of a 5.5-millimetre copper wire. The sectional view of one of the alternators shows the disposition of the field and armature and also of the inductor or revolving part of the machine. The latter consists of a set of revolving poles which do not carry a winding, but serve to complete the magnetic circuit as usual between the field and armature. As will be observed in the machine lying in the foreground of the general view, the movable part is formed of a steel cylinder or hub, carrying two series of seven polar projections. The pole-pieces are built of laminated steel, and are fixed to the hub by bolts. At the outer end of the alternator will be observed the small two-pole exciter which it carries, and each machine has its own exciter.

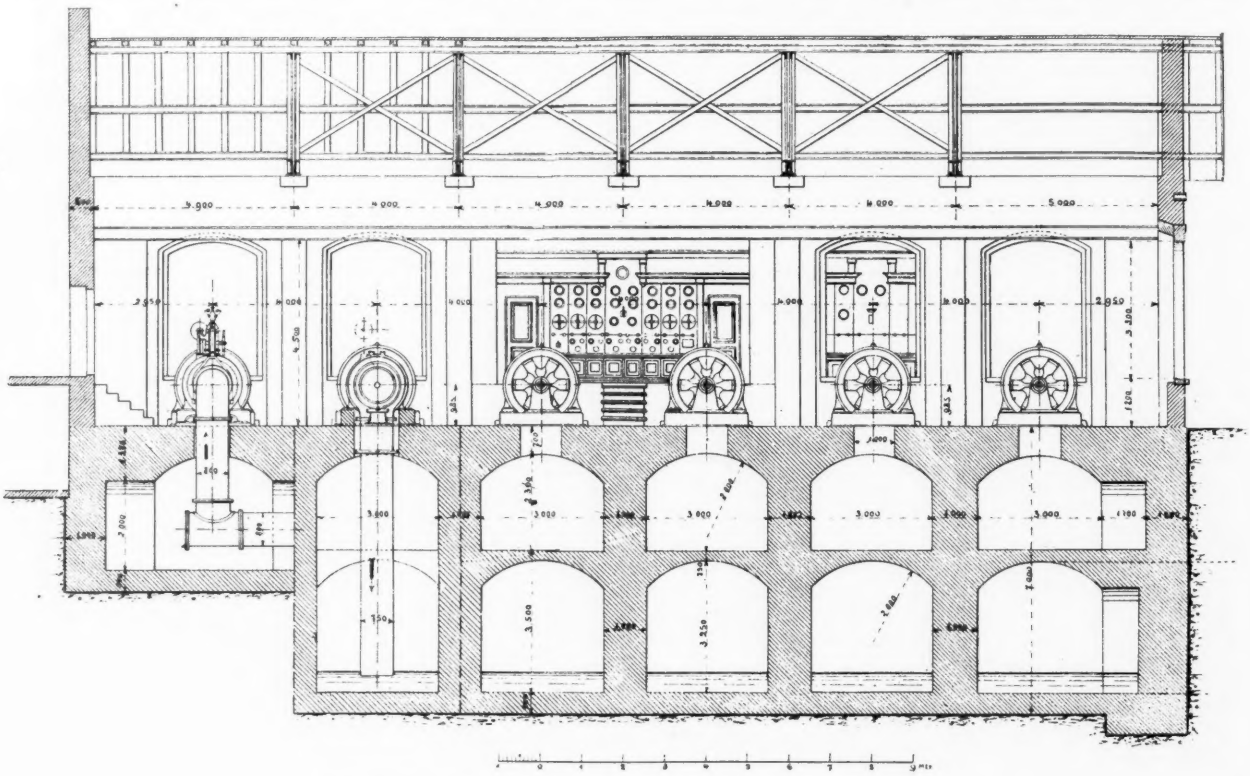
The switchboard for the alternators and the exciter circuits is placed in a separate room or annex opening into the main dynamo room, as will be noticed in the ground plan of the building. The

three-phase current is led from the alternators by cables to the switchboard. All the cables, which are mounted upon double porcelain insulators, are lodged in conduits under the floor of the station. The switchboard, in the first period of operating the station, had seven white marble panels for the main current and seven panels for the exciters. Afterward as the current supply of the station increased there were added five panels of each kind to the above number, and the annex had to be enlarged accordingly. The marble panels are mounted in frames of angle-iron, with a wood facing. Two doors give access to the space which lies behind the switchboard. The instruments, switches and other apparatus, as well as all the conductors of the board, are mounted upon double porcelain insulators. For each of the alternators there is a double-throw switch, allowing it to be placed upon one or the other set of bars. The handles of the switches, etc., are placed on the front side of the switchboard and are well insulated. Each of the machines has a panel for operating it. The panel carries a main switch, a changing-switch, an ammeter and a voltmeter. The latter is branched upon the secondary of a small transformer, as usual. On the secondary circuits of these transformers are also placed the phase-lamps. Each of the machine panels carries a set of instruments for the exciter, including the rheostat. In the centre of the board is a panel which carries the high-tension voltmeters, the totalizing ammeters of each line and the relays for the automatic regulation. There is also a switch which allows of coupling in parallel the two feeder lines of Sainte Croix and Yverdon, should a single machine be sufficient to give all the current for these two circuits.

An additional part of the switchboard carries the apparatus which are needed for lighting the station itself and the village of Les Clées (at 120 volts), and for supplying the motor of a sawmill near by; also for a line running to the cement factory of Baulmes. Behind the switchboard are two chambers. The first contains the rheostats, switches and fuses of the machines and the voltmeter transformers, while the second contains the fuses for the feeder lines and the lightning arresters.

The primary distribution lines at 5,200 volts, which start from the Les Clées station, are as follows: the main line between Les Clées and the towns of Yverdon and Grandson includes one set of overhead feeders between the station and Champs des Bois, having eight wires, one line from the latter point to Yverdon consisting of seven wires, and a third section from thence to Grandson, having four wires. The second distribution line runs from the station to Champs, Baulmes and Sainte Croix l'Auberson. The first two sections of the line have seven wires each, while the last section ending at Sainte Croix has four wires. As the energy which is taken by the lime and cement factory at Baulmes is quite variable, it was found best to run a special line of 7.5 kilometres from the station for this purpose, and thus avoid any fluctuations in the lighting circuits. The map indicates the general disposition of the circuits throughout the region which the Les Clées plant supplies with current. One of the engravings shows the method of mounting the poles and the high-tension lines, which run through a mountainous region for the most part. The wires are mounted on double porcelain insulators and are carried upon poles which are capped with an iron point connected to ground. The average distance between the poles of the overhead lines is forty metres. However, in some places where the lines are obliged to pass over a gorge, there are at least 300 metres, and sometimes 320 metres, between the two supports.

The total length of the high-tension circuits of the Les Clées system is about sixty-eight kilometres, or forty-two miles, and the total length of copper wire in these lines is 386 kilometres (240 miles),



Longitudinal Section, Les Clées-Yverdon Central Station.

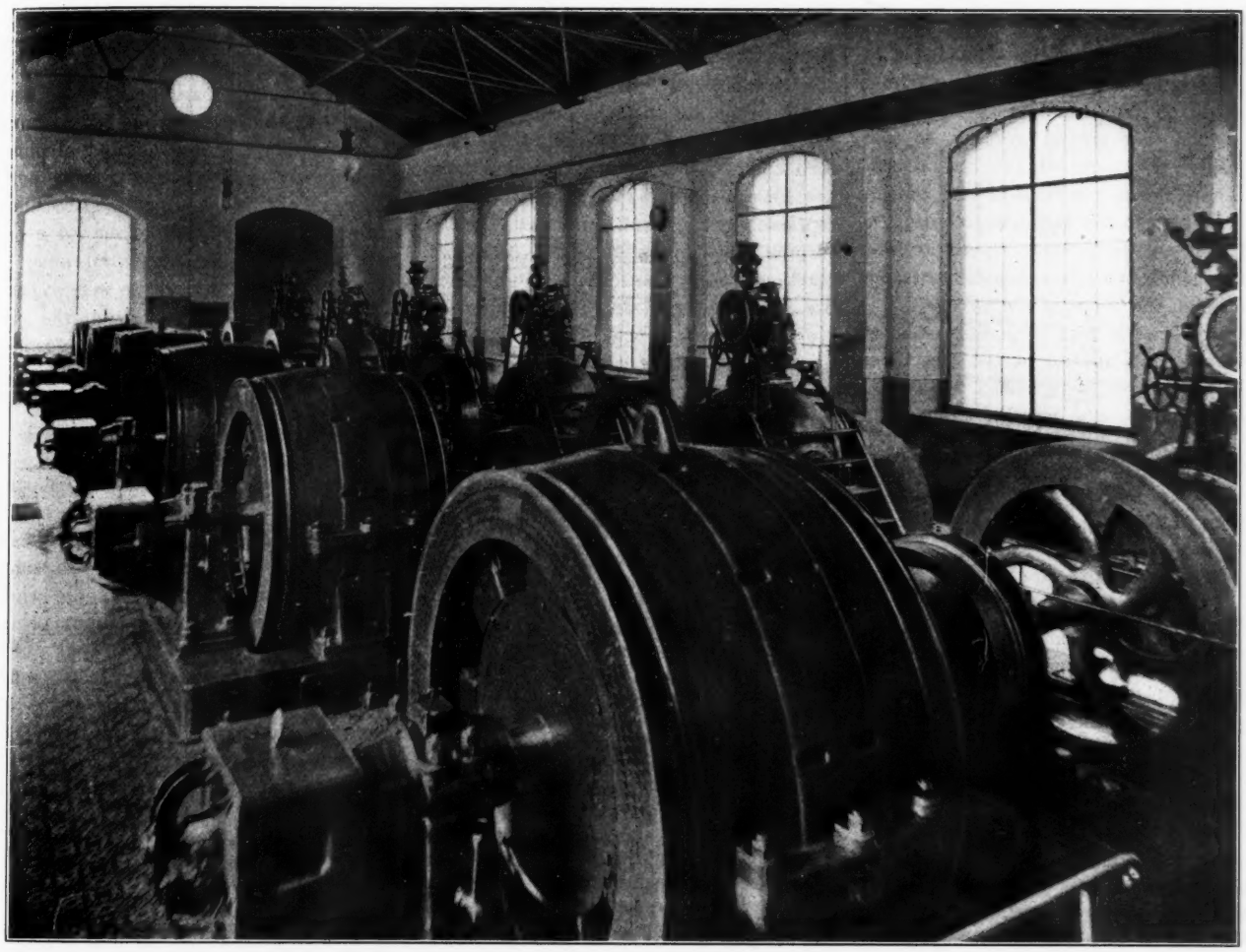
which gives a weight of copper equal to 9,416 kilogrammes, or over ten tons. In the whole system there are 1,478 poles and 8,232 insulators. The low-tension circuits figure for a length of 48.5 kilometres, or a length of wire equal to 204 kilometres and a weight of fifty-two tons.

The transformers which supply the secondary mains in the different localities of the region are placed in stations consisting in most cases of small masonry structures. In other cases the transformers are placed in the basements of buildings. The whole number of transformers which are employed throughout the Les Clées system is fifty, and these are contained in thirty-four stations, representing a total capacity of 1,038 kilowatts, although this figure is an estimate which was made some time ago, and there must have been a considerable increase in the consumption of current since that time.

On the secondary mains, which are supplied by the transformer stations, the lamps are operated at a tension of 120 volts. The lamps are equally divided upon the three phases of the circuit. Experience has shown that differences of load do not produce any marked effect upon the voltage, this being due on the one hand to the slight difference of load between the phases and on the other to the small drop in the voltage of the alternators when running under load. All the wires of the secondary circuits are overhead. In many cases the cables are run along the roofs of the houses so as to avoid encumbering the streets. In the town of Yverdon the secondary mains start from several transformer stations, while in the smaller localities there is but one such station for the whole town.

At last accounts there were some 110 three-phase motors installed in different places on the circuits. The capacity of the motors ranges from one-tenth up to 120 horse-power, representing a total of 800 horse-power. The shops which have been installed for the Jura-Simplon are using a considerable amount of power from the Les Clées plant, while the cement factory at Baulmes takes about 200 horse-power. The remainder of the power is used in different industries throughout the region.

One of the engravings shows a typical three-phase motor, built by the Oerlikon firm. It represents one of the large-sized motors, and in this case a set of collecting rings is employed. The rings are connected to a resistance which is thus placed in the circuit of the rotor. In this case the starting current is cut down, and in practice it is not much above the normal working current of the motor. The power absorbed by the motor in starting is about equal to the normal power when running at full load, or in other cases it is made nearly double the normal current, according to the construction of the motor, as a number of different types are used in the present plant. The motors which have a smaller capacity than two horse-power are run on the short-circuit system, while the larger motors use the extra resistance for starting. In the latter form, a device is provided which allows of putting the resistance coils in



THE GENERATING ROOM OF THE LES CLÉES-YVERDON HYDROELECTRIC STATION, CONTAINING SIX 300-HORSE-POWER DIRECT-CONNECTED UNITS.

short-circuit. This is done when the motor comes up to the proper speed. By lifting the brushes off the collector rings by means of a lever which is provided for this purpose and is mounted upon the motor, the resistance is cut out and the motor continues to run at the normal speed with the rotor in short-circuit.

In general, the motors are branched upon the secondary mains and are operated at low tension. The forty-five-horse-power motor which is used in the Yverdon factory is an exception to this practice, and here the motor is run directly upon the high-tension circuit. Seeing that all the larger sized motors are provided with the above-mentioned device for starting, the load on the circuit is varied gradually when they are set working, so that the speed-regulators of the central station have the proper time to vary the inlet of water to the turbines according to the demand for power. Owing to this arrangement, there is but little variation noticed on the lamps of the circuits.

A word may be said about the system of tariff which is in use in the Les Clées system. Current is furnished to the different localities at a very low rate, which induces the persons engaged in the various industries, particularly the smaller ones, to adopt it generally. The contract system is preferred for the lighting, and it is used exclusively. There are, therefore, no meters to be found on the lighting circuits. As an example of the rates, it may be stated that the tariff for a sixteen-candle-power lamp for 400 hours per year is fourteen francs ($2.80); up to 800 hours per year, nineteen francs ($3.80), and above 800 hours, twenty-three francs ($4.60). All the lamps which are installed in offices and shops which close at 6 o'clock P. M. are counted at the 400-hour rate. Where the hour of closing is from 6 to 8 P. M., the lamps are figured in the second class, and in all other cases the lamps pay the maximum rate. The current which is supplied to the Jura-Simplon shops is reckoned by meter.

For the motors, the contract system is also used. The scale of prices ranges from a one-half horse-power motor, at 240 francs per horse-power ($48), to 150 francs ($30) per horse-power for a thirty-horse-power motor. Above this capacity, a special tariff is figured. The small motors which are used only at light-load periods of the day, *i. e.*, from 8 A. M. to 4 P. M. in winter, or from 7 A. M to 6 P. M. in summer, are given the benefit of a special rate, which ranges from $0.02 per horse-power-hour for the smaller motors, to $0.015 for the larger units. The motors of the latter class are provided with watt-hour meters in their circuits. This tariff has the advantage of giving the small operators, who can dispose freely of their time, a motive power which is very cheap, and this during the period of the day when the central station would otherwise be running on a very light load.

A Direct-Current Turbo-Generator of the Maschinenbau A. G. Union.

A description of a turbo-generator exhibited at the Liege Universal Exposition is described briefly by M. G. Reyval in *L'Éclairage Électrique* (Paris), for November 4. This unit is of the vertical type, the turbine being placed below, with the generator above. The latter machine is not described, though from the illustration it apparently has an exceptionally long, small commutator. The turbine is a combination of the action and reaction types. The lower section, which first receives the steam, is of the action type, and has four wheels, steam impinging upon the outer periphery, rebounding, and being carried by a series of channels to the four wheels in succession. From here it passes through the reaction wheel, which consists of five rows of blades, dovetailed into the outer rim of a nickel-steel spider. The steam passage through these buckets increases in area, allowing the steam to expand on its way through. The weight of the shaft is borne by a step-bearing, lubricated by oil under pressure, the pressure being supplied by the exhaust steam, so that the quantity of oil passing through the bearing varies with the load. Oil, after passing through the bearing, is received back into a reservoir, where it is cooled by water pipes. The turbine is governed by controlling the quantity of steam admitted through the inlet nozzles. This particular unit was rated at 300 horse-power, and revolved at 3,000 turns per minute. The performance was said to be a consumption of 6.3 kilogrammes of steam per horse-power-hour, with a superheat of 300 degrees, at a steam pressure of 175 pounds.

The Independent Telephone Association of Wisconsin.

The annual convention of the Independent Telephone Association of Wisconsin, will be held in Milwaukee, Wis., December 20 and 21. The headquarters will be at the Pfister Hotel. The Wisconsin convention have always been held in February, but the date has been changed to December, as it is considered a more favorable time. An interesting programme has been prepared, and the usual large attendance is expected. Mr. H. C. Winter, Madison, Wis., is the secretary and treasurer.

NOTES ON ALTERNATE-CURRENT INDUCTION MOTORS.[1]

BY T. HARDING CHURTON.

In this paper the author proposes, first, to compare the performance and characteristics of motors of the induction type when provided with short-circuit and with wound rotors, respectively; secondly, to compare the performance of such motors on single-phase and polyphase circuits, respectively; and thirdly, to indicate, by comparisons, the extent to which the working of such motors is affected by the frequency of alternations. For the purpose of illustrating the above comparisons, the performance of a particular size of machine with short-circuit and with wound rotor, for single-phase and for polyphase working, and on circuits of various periodicities, will be shown, the particulars given being the results obtained from actual tests on a number of machines of the same size. The windings were in each case appropriate, of course, to the circuit upon which the motor was to operate. It is not suggested that the comparative results here shown necessarily apply in all cases, but they may at least be taken as fairly representative.

When an induction motor is started up, the field of the stator starts at once to revolve at the full speed of the motor, and the rate at which it cuts the rotor conductors falls from a maximum when the rotor is at rest to a minimum when the highest speed of rotation is attained. The currents thereby reduced in the rotor conductors lag behind the stator field, the difference in phase depending upon the strengths of the currents, which will depend, of course, upon the resistance of the circuits. And the field due to the rotor currents, reacting upon the stator field, which it consequently weakens, is also, of course, dependent upon the resistance of the rotor circuits. But the torque exerted by the rotor being proportional to the strength of the stator field and rotor currents, and inversely proportional to the phase difference between them, the maximum torque of the motor at a particular speed depends, therefore, upon a certain value being given to the rotor resistance, which value decreases as the speed of the motor increases up to synchronism. For this reason, a motor provided with a rotor, into the circuits of which (either through slip-rings or other device) external resistance may be inserted and gradually cut out as the mo-

[1] Paper read before the Leeds local section of the Institution of Electrical Engineers, of Great Britain.

tor gains speed, starts up better than one having permanent connections. This may be expressed by the formula

$$R_0 = R_2 \times \frac{n_1}{n_1 - n_2}$$

where

R_0 = total resistance of rotor circuits;
R_2 = ohmic resistance of rotor winding;
n_1 = frequency of stator currents (or speed of stator field);
n_2 = frequency of rotor currents (or slip of rotor).

In the case of two-phase or three-phase motors a considerable starting torque may be obtained with short-circuit rotors having conductors of comparatively high resistance. But such resistance seriously affects the efficiency, as well as the slip, of the motor when running on load, and motors so constructed are usually employed, therefore, only for intermittent work, such as, for example, operating cranes. When an induction motor is required to combine relatively high starting torque and high efficiency on load, it should have a wound rotor and variable starting resistance. If, however, so high a starting torque is not required, the short-circuit rotor, with low-resistance conductors, is preferred on account of mechanical superiority, greater electrical efficiency, and overload capacity. In a short-circuit rotor the currents and field are much more evenly distributed than in a wound rotor, and the former is consequently less liable to have "dead" points at starting. And though, owing to the more definite polar winding of the wound rotor, the average torque is greater than that of the short-circuit rotor, yet when the coils of the rotor are exactly opposite the coils of the stator, the torque is less than that of the short-circuit rotor. Again, with the wound rotor, the number of slots in the stator and rotor must have a common factor which conduces to a cogging effect.

But a further desideratum in the choice of the type of motor, particularly when of large size, is the maximum current that may be drawn from the mains at the moment of starting, and which will not interfere with the pressure regulation of the supply. As before mentioned, the field due to the rotor currents reacts upon the stator field, which it more or less wipes out, and thus, by reducing the self-induction of the stator coils, allows an increase of current to flow through them from the mains. Now, when a motor with an ordinary short-circuit rotor is started, the currents induced in the rotor are very great, and the current drawn from the mains must also, therefore, be considerable. If a polyphase motor of high efficiency with short-circuit rotor is switched directly on to the mains, with a periodicity of, say, fifty cycles, there will be a momentary rush of current equal to about three to five times full-load current, while the resulting starting torque will be about two and a half to four times full-load torque. If the pressure of the supply current is reduced by a transformer starter, the current from the mains may be reduced to, say, about full-load current, when the torque will be equal to about one-half to three-quarters full-load torque. With a wound rotor, a similar machine would give full-load torque with full-load current, and this current could be switched on gradually.

The type of transformer usually employed for starting polyphase motors with short-circuit rotors is that known as the autotransformer, which consists, for each phase, of a single coil wound upon an iron core forming a closed magnetic circuit. By tapping the coil at a point intermediate between the two ends, the voltage may be readily obtained that limits the current drawn from the mains to the permissible value, while allowing a considerably greater current to flow into the stator windings. With regard to the starters for motors with wound rotors, as the rotors are invariably provided with a three-phase winding the regulating resistance is always in three divisions. Liquid resistances are sometimes used, but more frequently wire or metal strip multiple-contact rheostats are employed. The curves shown in Fig. 1 are from tests taken upon two motors, one having a short-circuit rotor and the other a wound rotor, but which were in other respects identical machines. It will be noticed that both the efficiency and power-factor are higher in the case of the machine with the short-circuit rotor. Both machines were constructed to give five brake horsepower at about 1,420 revolutions on single-phase, 200-volt, fifty-cycle circuit. The starting torque obtained with the short-circuit rotor machine was 0.45 full-load torque with 1.25 times full-load current, while the wound-rotor machine gave 0.75 full-load torque with full-load current. The slip is somewhat greater with the wound rotor, which would, moreover, pull out of step rather sooner than the short-circuit rotor. The difference between the results obtained with the short-circuit and wound rotors on polyphase working is practically the same as that on single-phase, though with the polyphase system the results themselves are much better, as will be shown later.

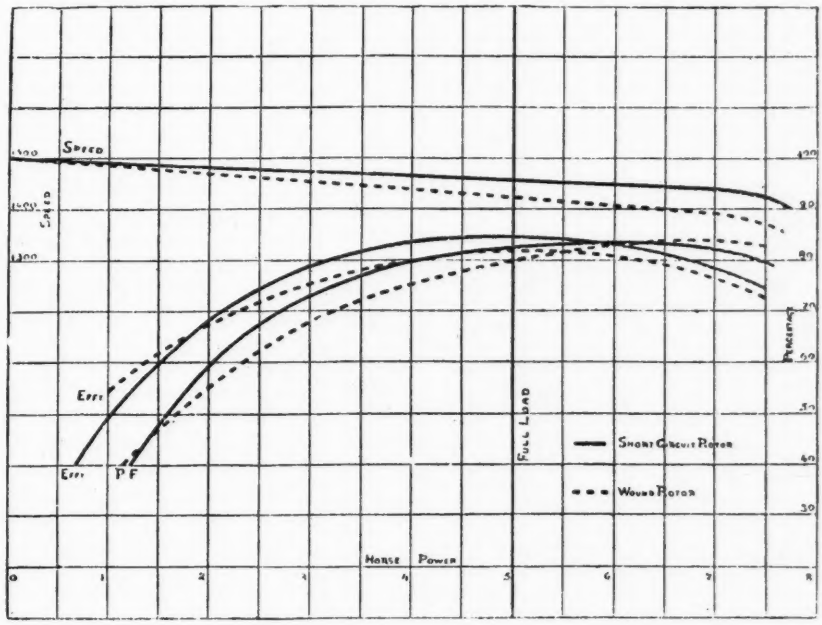


FIG. 1.—CURVES FROM TESTS ON TWO MOTORS: ONE WITH SHORT-CIRCUITED ROTOR; ONE WITH WOUND ROTOR.

Speed regulation has been so far, perhaps, the least satisfactory feature of the induction motor. The usual methods adopted are: first, the insertion of non-inductive resistance in the rotor circuits; secondly, alteration of the number of poles of the stator, and, in the case of wound rotors, those of the rotor also; and thirdly, varying the voltage on the stator either

by the insertion of resistance in the mains, or by transformer. With regard to the first of these methods, the one mostly in use, though possessing the advantage of simplicity, has the disadvantage of being uneconomical, being analogous, in fact, to the insertion of resistance in circuit with the armature of a direct-current shunt-wound motor. A further objection—one which also applies in the direct-current example—is the instability of the speed with varying load. If any considerable reduction in speed is attempted in this manner, it may become so susceptible to variations in the load as to render certain operations difficult or impossible. For many purposes, however, this method answers sufficiently well, and where the work is of an intermittent character the question of economy is not, of course, of much consequence. The second method, that of altering the number of poles, is not only complicated, involving many connections, particularly in the case of the wound-rotor machine, and low efficiency and power-factor, but is open to the further objections that the number of steps thus practicable is very limited, and that the system is too costly for general use. The third method, that of reducing the voltage on the stator windings, is the most wasteful of energy and the least effective. For the purpose of speed regulation, then, the wound-rotor motor is the more satisfactory, though for some purposes, such as operating cranes, the short-circuit rotor, with conductors of relatively high resistance, combined with graduated transformers for varying the voltage on the stator windings, is sometimes preferred for polyphase motors.

To compare, now, the performance of the motor on single-phase and on polyphase working, it must be remembered that the field produced in the single-phase motor is not a uniformly rotating field as it is in the case of a polyphase motor. When the rotor is at rest, a simple alternating current in the stator winding would produce only an oscillating field which would not cause the rotor to move at all. To start up the motor, therefore, a second winding is placed at ninety degrees to the main winding, and by causing the current to lag in one winding and giving a lead to the current in the other winding, a phase difference is produced which creates a rotating field. But whereas the currents in a regular two-phase stator differ in phase by ninety degrees, those in the single-phase motor can not be made in the above manner to differ by anything like so much, and the resulting field is, in consequence, very irregular. As the rotor gains speed the field due to the combined action of the stator and rotor currents becomes more uniformly rotating, but never attains to the uniformity of the field produced by the polyphase currents. For the above reason, motors of this type have not nearly so good a starting torque on single-phase as on polyphase circuits. And, for the same reason, the maximum running torque and brake horse-power of the motor is less when working single-phase than polyphase, and the single-phase motor will, moreover, pull out of step and stop with less overload than the polyphase motor will carry. Table I shows the performance of the motor with regard to starting torque and current on single and two-phase circuits of fifty cycles, 200 volts, and with short-circuit and wound rotors, respectively. The superiority of the polyphase motor in this respect is clearly shown.

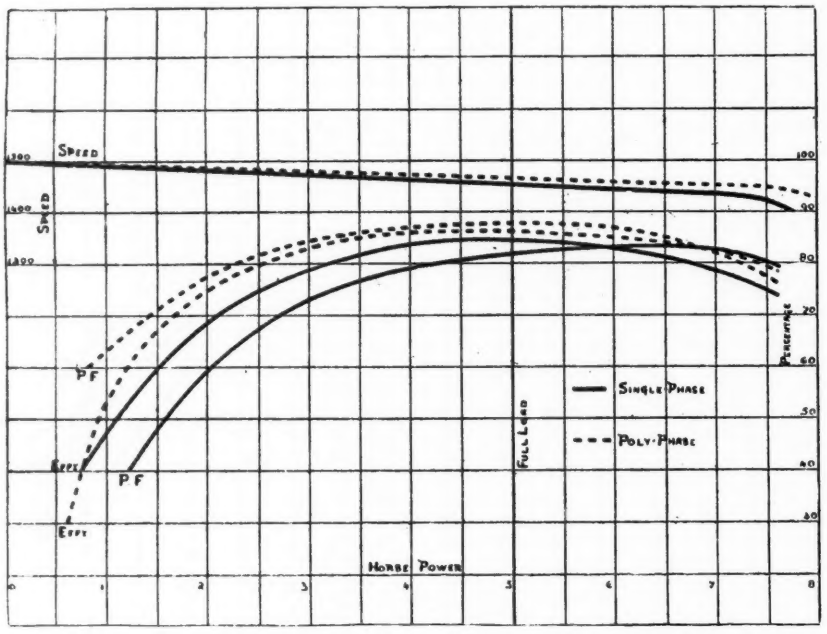


Fig. 2.—Motor Performance on Single-Phase and Polyphase Working.

TABLE I.

	Single-Phase.		Polyphase.	
	Starting Current.	Starting Torque.	Starting Current.	Starting Torque.
Short-circuit rotor.	1.25	0.45	1.25	0.75
Wound rotor.....	1.0	0.75	1.0	1.0

Note—The figures refer to the normal full-load values.

The curves in Fig. 2 show also that the efficiency and power-factor are higher in the case of the polyphase motor, and that the slip is greater in the single-phase motor. The lower efficiency of the single-phase motor is accounted for by the greater iron losses due to the irregular flux and to the torque being lower on account of the irregularity of the field. And the power-factor is also lower because the greater slip of the rotor retards the rotor field, which consequently becomes more out of phase with and thus opposes the stator field. The leakage coefficient and self-induction of the stator winding are thus increased and the power-factor is, therefore, reduced. A great deal of attention has been paid to the methods of starting the single-phase motor, the principal object being generally to obtain as great a phase difference as possible between the currents in the main and starting coils. Condensers, which were formerly extensively used in this connection, have been abandoned on account of the trouble they gave through heating, varying in capacity with varying temperature, and by breaking down. Choking coils were also much more used than at present, the required self-induction now being usually obtained by suitably winding the auxiliary coils. The method of starting adopted by the author is to connect the main and starting coils in series, and a non-inductive resistance across the starting coils—that is, in series with the main winding to which it gives a lead—while the self-induction of the starting coil gives the current flowing in it a considerable lag. The auxiliary winding occupies about one-quarter of the stator winding space, and is wound in the centre of the main poles, where the main winding could not be usefully employed. It is usually wound with either one-half or twice the number of turns of the main winding. The author prefers the fewer number of turns on account of the other-

wise high induced voltage continually on the windings tending to break down the insulation. In some makes of motors this risk of failure of insulation is still further increased by one end of the auxiliary coil being left connected to one end of the main winding, in which case the voltages of the two windings are in series. Thus, in a 200-volt motor the voltage on the windings may be about 550 volts, depending upon the phase difference of the voltage in the windings.

There are several means by which the starting torque of the single-phase motor may be somewhat improved, but which involve lower efficiency on load. And, as in most other problems in engineering, the question as to how far the running efficiency shall be sacrificed to improve starting performance is a matter of compromise. The results actually obtained depend, of course, upon the details of design, particularly with regard to the flux densities, shape of the stator and rotor teeth, and length of air-gap, as well as upon the materials employed, particularly the quality of the iron in the stator. While the single-phase motor can not upon equal terms compete with the polyphase motor, it is, nevertheless, in its better forms an excellent machine

The question of frequency is a very important matter with regard to induction motors. In the first place, the torque exerted by the motor is inversely proportional to the frequency of the supply current, and a given size of motor will, therefore, be capable of giving twice the horse-power on, say, fifty cycles that it can give at the same speed on 100 cycles. In order, therefore, that the motor may give the same maximum horse-power on 100 cycles as on fifty cycles, the speed must be doubled. The loss due to hysteresis is directly proportional to the frequency. If, therefore, the frequency is greatly increased, the induction—and therefore the torque—must be much reduced to prevent heating of the iron and noise. But the magnetization curve not being straight, the watts spent in magnetizing are not diminished in the same ratio as the induction is reduced. Thus the iron loss is greater at the higher frequency, and, other things being equal, the efficiency of the motor is, therefore, lower. And the leakage coefficient being greater at the higher frequency, the power-factor is, therefore, lower. This again, by increasing the currents increasing the C^2R losses which, therefore, further reduce the efficiency. The hysteresis loss and leakage coefficient increases much more rapidly on the higher range of frequencies than on the lower. For example, the difference is much greater between fifty cycles and 100 cycles than between twenty-five and fifty cycles.

The curves in Fig. 3 show the difference in the efficiency, power-factor, and slip of the same size of motor as before referred to when giving five brake horse-power on fifty cycles at about 1,430 revolutions per minute, and the same horse-power on 100 cycles at 1,880 revolutions per minute. It will be here observed that the speed on 100 cycles is not, for the same horse-power, double that on fifty cycles, as would have been expected from the statement above. But it may be explained that this was due merely to the exigencies of manufacture, the same standard stampings having been utilized in each case and the windings varied to obtain the required output with the best results. While this arrangement occasionally necessitates the use of a machine somewhat larger than actually required, economies in manufacture are effected which repay the extra cost of material involved. When it is remembered that there are in the United Kingdom alone over 100 alternating supply systems, of which about eighty-six are single-phase, working at no less than seventeen different frequencies, besides two-phase and three-phase, each with its own variety of frequencies, it will be understood that a manufacturer could not profitably make so great a variety of special patterns as would be required to obtain the greatest possible effect from a given size and weight of machine in every case. High frequency is not only prejudicial to efficiency, power-factor and torque, but is particularly detrimental to good starting performance.

TABLE II.

Starting torque and current on fifty cycles and 100 cycles of five-horse-power motor (short-circuit rotor)—200 volts.

Cycles.	Starting Current.	Starting Current	R. P. M.
50	1.25	0.45	1,430
100	2.0	0.43	1,880

This will be seen from table II, which gives the starting torque and current of the five-horse-power motor on fifty cycles and 100 cycles respectively. It may be remarked that on circuits of 100 cycles about twice the full-load current is usually taken for starting short-circuited rotor motors, whereas on fifty cycles the starting current does not usually much exceed the normal full-load current.

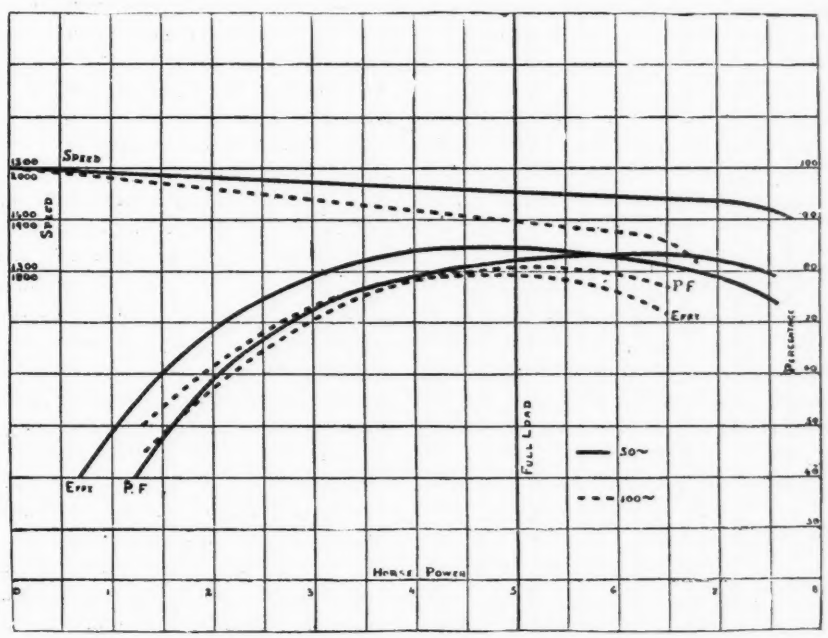


Fig 3.—Motor Performance at Frequencies of Fifty Cycles and 100 Cycles.

High periodicity, then, to the motor user implies (1) higher cost of motors, and (2) higher cost of working, and to the electricity supply undertaking it means (*a*) lower day load (because of the less inducements to power users to adopt the supply) and (*b*) greater proportional loss on mains, etc., on account of lower power-factor of motors. Most of the systems having frequencies above fifty or sixty cycles were established before induction motors were practically thought of. Some of these are, happily, being gradually changed over to fifty or sixty cycles, and it would be well if a frequency of fifty cycles were adopted whenever possible. Standardization in such matters greatly promotes economy and excellence in manu-

facture, promptitude of delivery, and is, from every point of view, a consummation devoutly to be wished.

In concluding these notes, a brief reference to the single-phase repulsion motor may not be out of place. If a copper ring is suspended in an alternating field, it tends to turn so that its plane is parallel to the direction of the flux, in which position it does not enclose any magnetic lines. If placed with its plane at right angles to the flux, it will not move, the tendency to turn in one direction being balanced by an equal tendency to turn in the other. Midway between these two positions—that is, at forty-five degrees to the flux—the tendency to turn would be at its maximum, provided that the currents induced in the ring were in phase with the primary field. Owing, however, to the self-induction of the ring causing the currents induced in it to lag, the position of the ring that gives maximum torque is moved correspondingly forward. If, therefore, an ordinary direct-current armature is placed in an alternating-current field and the brushes given a slight lead in either direction, and short-circuited, the armature (or rotor) will rotate. The function of the brushes is merely to short-circuit the coils as they successively come under the poles, and only those coils that are thus short-circuited are exerting a torque. The object of connecting the brushes together is—if the armature has a parallel winding—to equalize any irregularity of pressure, just as equalizing rings are sometimes employed in multipolar direct-current armatures. If the armature is series-wound, the connecting ring is required to short-circuit the coils. The speed characteristic of such a motor is similar to that of a series-wound direct-current motor—it will race if run without load, and the torque exerted, varies inversely as the speed—and is, therefore, greatest at starting. If the armature windings are suitably connected to three slip-rings to enable resistance to be inserted at starting, and which can be gradually cut out as the motor gains speed, the starting will be improved and the starting current reduced. The effect of connecting the rotor windings in this way is that currents flow in all the conductors, thereby exerting a torque just as in an induction motor. And as the speed of the rotor increases up to synchronism the currents in the rotor come more into phase with those in the stator, and thus the torque due to this inductive effect increases with the speed. We have thus a compound effect, which results in a gradual decrease of torque from that due to the initial repulsion effect to the maximum running torque of the machine as an induction motor. For operating hoisting machinery, and many other purposes, such a motor is very well adapted.

On a fifty-cycle circuit the starting torque may be as great as twice the full-load torque with less than 1.5 times full-load current, while three times full-load torque may be obtained at starting with about twice the full-load running current. And if when the motor has run up to speed the slip-rings are short-circuited, the motor will run practically as an ordinary induction motor. If the brushes are left on the commutator they continue, of course, to short-circuit the coils, which, therefore, continue to exert a torque due to the repulsion effect and tend to race. On the other hand, the induction action of the remaining conductors tends to run the motor at synchronism. The result is that, when running light, the speed of the motor is a little above synchronism.

The efficiency and power-factor of the repulsion motor are not quite so high as those of the induction motor, the current taken for the same horse-power and on the same voltage and periodicity being about ten per cent higher; and the horse-power of the motor is roughly seventy per cent of that which it would be as a single-phase induction machine. Reversing the direction of rotation may be effected either by shifting the brushes to the other side of the neutral position on the commutator, or by shifting the position of the poles themselves. The latter may be accomplished by employing two sets of windings on the stator inclined to one another at the same angle through which the brushes would otherwise have to be moved. Either winding can, of course, be brought into operation by a simple two-way switch. The stator winding is switched directly on to the mains, and the starting current may be kept within the limits usually required by means of the regulating resistance in the rotor circuits. As is well known, when a circuit carrying a current is suddenly opened, the current tends to jump across the break in the form of a spark. And the tendency to spark as the short-circuited coils leave the brushes will, therefore, be understood. This has been, in fact, a serious difficulty with the repulsion motor. However, if the reactance voltage is kept sufficiently low, and the machine provided with slip-rings—so that the circuits are not really broken—the difficulty of sparking may be quite overcome. The prevention of sparking may, indeed, become more difficult in machines of large size, but with regard to that the author has not sufficient data to give particulars.

LONG-DISTANCE TELEGRAPHY IN AUSTRALIA.

BY T. HOWARD.

On Sunday morning, September 24, 1905, a somewhat remarkable achievement was attained in a trial of long-distance working over the Australian telegraph lines. Mr. Jenvey, electrical engineer for Victoria, who was on an official visit to Western Australia, had made the suggestion during the preceding week that a trial should be made on the following Sunday, and the admirable cooperation of the electrical engineers in the other states of the federation resulted in Broome, a station on the north coast of Western Australia, being placed in easy and perfectly plain communication with Cape York, an office on the extreme northern point of Queensland, over a distance by the route of the line of 6,601¼ miles.

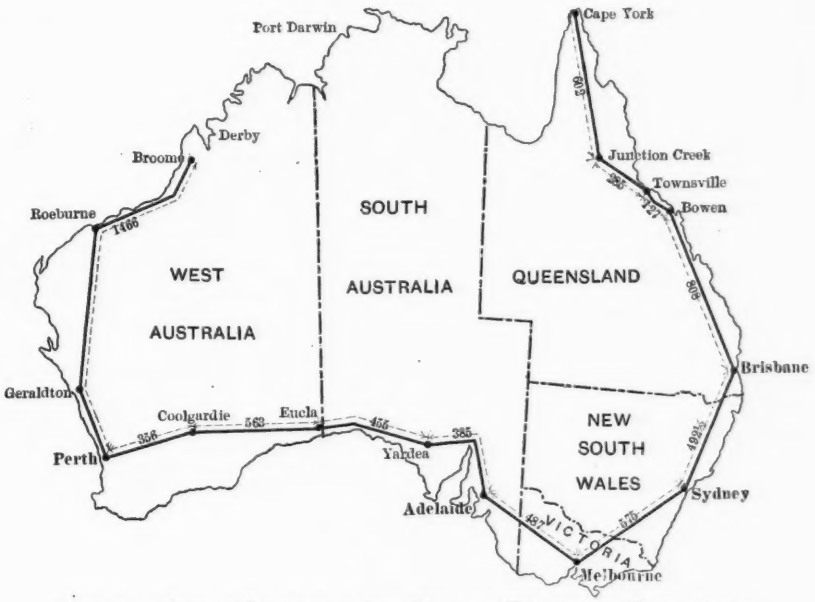
The experiments were commenced at 11 A. M., Melbourne, Sydney, Brisbane time, which under the prevailing zone system was 9 A. M. at Perth. Adelaide, Melbourne, Sydney, Brisbane and Townsville were in attendance and ready at the former hour and greeted each other. Cape York was then joined to the circuit, the signals to and from him being clear and firm. Owing to an unexpected delay at Eucla, which is a main repeating station situated on the great Australian bight, Perth was not in a position to communicate with Melbourne and the other capitals until 12 noon, but when he did appear there was no difficulty in speaking through to Cape York freely and well. Broome, a duplex station, 1,466 miles distant from Perth, was then connected to the circuit and he and Cape York passed the time of day and carried on a conversation for fifteen minutes, at a key speed of twenty words per minute, without the least sign of lag in the signals. Broome stated that the temperature was 100 degrees in the shade there, while Cape York set it down at eighty at his end.

The signals passed from one terminal station to the other splendidly, annihilating distance in a most pronounced manner, and amply demonstrated to the satisfaction of all concerned that through telegraph working from one end of Australia to the other was a practicable feat. With the arrival of this successful issue the terminal stations were taken off, the intermediate circuits were dismantled, and the experiments came to an end.

Sunday morning was chosen for the test as being the most suitable time. Except for occasional private and a few

press telegrams and the clearing off of "delayed business," which happily now is a very rare requirement owing to the numerous routes available, those engaged in telegraph work have very little local business other than the receipt and despatch of shipping intelligence to occupy them on Sunday mornings. The steady load does not commence until about midday, thence going on during the afternoon and evening. It is obvious that such a trial could not be properly carried out during any week day without interfering with the ordinary telegraphic business as all the main circuits connecting the capitals and those radiating from the latter to the various local provincial centres are kept fully, or at least fairly, well occupied with traffic. Those who have the management of telegraph staffs and lines will readily appreciate this statement.

By referring to the attached skeleton map of Australia the course of the circuit can be readily traced. There were thirteen repeating stations, numbered in the column 1 to 13, and the various sections of line were made up as follows:



COURSE OF CIRCUIT COVERED IN LONG-DISTANCE TELEGRAPHY EXPERIMENTS.

No.	From.	To	Telegraph System.	Class of Line Wire in Use.	Distance in Miles.
..	Broome	.....	....	.....	...
1	Repeater at Broome	Roeburne			
2	" "	Geraldton	Duplex	400 lbs. iron	1466
3	.....	Perth			
4	Repeater at Perth	Coolgardie	Quad	200 lbs. copper	356
5	" Coolgardie	Eucla	"	"	563
6	" Eucla	Yardea	"	300 lbs. copper	455
7	" Yardea	Adelaide	"	"	385
8	" Adelaide	Melbourne	"	"	487
9	" Melbourne	Sydney	"	800 lbs. iron	575
			"	400 lbs. copper	173¾
			"	300 lbs. "	318
10	" Sydney	Brisbane	"	Sub. cable	¾
			"	Aerial cable	¾
11	" Brisbane	Bowen	Duplex	200 lbs. copper	430
			"	400 lbs. iron	378
12	" Bowen	Townsville	"	"	127
13	" Townsville	Junction Creek	"	"	285
14	" Junction Creek	Cape York	"	"	602
		Grand total.....			6601¼

Some ten years ago when Mr. Jenvey was in West Australia, *viz.*, on Sunday May 26, 1895, a similar trial was made, and on that occasion Derby, a station 124 miles north of Broome, was linked to the circuit. At that period the various state postal departments of Australia were working under different and separate administrations, some using the Universal and others the Australian telegraph code, which fact reduced the key speed to ten words per minute for that trial. All Australian departments are now subservient to the control of one central federal office, and the Universal code has become general since 1897. For some reason not assigned, Derby was not available for the recent test. There is no direct line connecting Derby to Port Darwin, or the latter to Cape York, so that it was not possible to encircle the whole of the continent by one speaking circuit.

The composite nature of the line and the character of the ground traversed must be considered in estimating the value of this achievement. Some sections pass over desert, forest, and mountainous country and through water, and are exposed to the destructive effects of high winds, storms and rain, also damage from passing traffic. In order that a test of the description under review may be successfully carried out it is necessary that the sections of the line must be in good working condition; that the repeaters should be well adjusted and carefully watched; that the batteries must be well up to their maximum strength, and there should be a good local management and supervision of the circuits.

So far as is known here, actual demonstration over such a lengthy circuit is rare, and it is probable that nothing of the same nature has been accomplished in any other country.

The following were the technical officers principally concerned in the test: Messrs. Jenvey and Diercks at Perth, Mr. Unbehaun at Adelaide, Messrs. Howard and Fitzgerald at Melbourne, Mr. Nelson at Sydney, Mr. Hesketh at Brisbane, and Mr. Murphy at Townsville.

Convention of Independent Telephone Companies.

A convention of the independent telephone companies of Vermont and New Hampshire was held at the Hotel Wentworth, Woodsville, N. H., on Thursday, November 2. The object of the convention was to form an independent telephone association of all the companies in Vermont and New Hampshire. An organization was formed, and the following officers elected: president, H. W. Buchanan, Barton Landing, Vt.; vice-president, C. D. Eastman, Woodsville, N. H.; secretary and treasurer, G. W. Buzzel, St. Johnsbury, Vt. Twenty vice-presidents were elected to serve as committees of arrangements. The association will be called the "Vermont & New Hampshire Independent Telephone Association."

The emblem adopted at the Chicago convention of the National-Interstate Telephone Association was adopted.

New York Central & Hudson River Railroad Company.

Electrification of the New York Suburban District—Transmission Lines and Substations.

THE current generated at the two main power stations at Port Morris and Yonkers is transmitted as three-phase, twenty-five-cycle, 11,000-volt alternating current to eight substations located as follows:

No. 1, Fiftieth street and Lexington avenue, Grand Central terminal, New York.
No. 2, Mott Haven.
No. 3, Kingsbridge.
No. 4, Yonkers.
No. 5, Irvington.
No. 6, Ossining.
No. 7, Bronx Park.
No. 8, Scarsdale.

The transmission lines are partly overhead and partly underground. The system is designed to give the greatest protection against interruptions of all kinds. Each substation may be fed from either power station and the lines are so disposed that no ordinary accident could cut off a substation from its power supply.

All overhead transmission lines are supported by latticed steel poles set in concrete foundations. Conductors will be of either 4/0 bare copper wire stranded cable or of aluminum stranded cable, spaced thirty-six inches apart on the cross-arms. Cross-arms will be of yellow pine. The insulators will be supported by steel pins. Poles will be spaced 150 feet apart on tangent and closer on curves as existing conditions demand. An experimental line has been erected by the company so that its engineers may develop the installation to the fullest degree.

All overhead lines are protected by the latest form of lightning arresters, and details of the overhead construction have been considered so minutely that the success of the system is assured.

Underground cables have three conductors of 4/0 stranded copper with paper insulation and lead sheathing. Duct lines are of vitrified tile covered with waterproofing and laid in concrete. The manholes placed at stated intervals on the lines are designed for arrangement of cables with regard to the best manner of handling and supporting them when they are installed. Each cable lies on shelving of concrete supported on iron pins. These shelves can be removed when necessary and are designed to facilitate the easy handling of cables as well as protection to sheathing and splicing. Manholes are roomy and are laid out to permit the bending of cables in easy curves. Much ingenuity has been used in the construction of these underground lines and manholes and many of the ideas developed are novel.

Through the Park avenue tunnel and along the viaduct, and also through the Harlem division depression, the conductors will be carried in three and one-half-inch steel pipes supported by brackets.

Across the Harlem river the conductors will be in a submarine cable laid in a dredged trench in the bed of the river, back-filled with gravel.

At points where the lines change from overhead to underground construction, cable towers of attractive architectural design will enclose the connections, together with lightning arresters and disconnecting switches.

At the substation the high-tension current is stepped down to direct current at 666 volts for delivery to the third rail. The main equipment of each substation consists of three rotary converters and their accompanying transformers and subsidiary apparatus. The arrangements provide for a future installation of five rotary converters. The relative locations and capacity of the substations are as shown in the following table:

Sub-Sta. No.	Location	Area of Main Floor. Square Feet.	Miles from Grand Central Station.		Present Installation of Rotary Conductors.	Future Installation of Rotary Conductors.
1	Grand Central Ter.	4,796.6	0.38		3 of 1,500 kw.	5 of 1,500 kw.
2	Mott Haven.....	3,845.27	5.47 5.49	(Hud. Div.) (Har. Div.)	3 of 1,500 kw.	5 of 1,500 kw.
3	Kings Bridge.....	3,845.27	9.44		3 of 1,000 kw.	5 of 1,000 kw.
4	Yonkers	3,639.33	15.64		3 of 1,000 kw.	3 of 1,500 kw.
5	Irvington	3,845.27	22.11		3 of 1,000 kw.	5 of 1,000 kw.
6	Ossining	3,845.26	30.31		3 of 1,000 kw.	5 of 1,000 kw.
7	Bronx Park.....	3,845.27	9.30		3 of 1,000 kw.	5 of 1,000 kw.
8	Scarsdale	3,845.27	19.02		3 of 1,000 kw.	5 of 1,000 kw.

Each substation is provided with a battery equipment, described below, and provision is made for any extensions that may be expected from increase of traffic.

The following general principles were adopted in the design of the substations: (1) the path of the energy to be as direct and as short as possible from the high-tension transmission lines to the direct-current feeders; (2) the wiring to be as little exposed as possible and yet be readily accessible; (3) all machinery to be on the same floor as the operating boards; (4) the principal apparatus to be under the direct control of the operator while standing at the operating boards; (5) all apparatus and machinery to be so arranged that the effects of an accident will be confined to the place where it occurs; (6) the risk of accident to the operator to be as slight as possible, and (7) stations to be fireproof.

In pursuance of the first idea, the apparatus is arranged in the following order across the station: entrance of high-tension lines, high-tension switching apparatus, transformers, rotary converters, direct-current switching apparatus. Along the station there is a succession of complete units such as that described above, the controlling apparatus being located at the centre. The second requirement necessitated the use of wall chases for the high-tension lines, and determined the use of transformers having both high-tension and low-tension terminals underneath the main floor. The third requirement determined the omission of galleries except for lightning arresters. The fourth requirement introduced the use of electrically operated switches and circuit-breakers for both the high-tension alternating current and the low-tension direct current. All of these switches and circuit-breakers are operated from the control boards. The fifth requirement settled the ample spacing of the machinery and introduced a very complete system of barriers for the protection of live conductors, an arrangement which is of great service in protecting the operators from danger.

The underground lines enter the basement through ducts and are terminated at end bells where they divide into three separate conductors running to three series transformers which supply current to the measuring instruments. The scheme adopted for the entrance of overhead lines was settled after a careful examination of all systems in use and is believed to afford the best possible protection against rain and snow not only to the incoming line, but also to the apparatus in the building.

The design of the lightning arresters was made with the view of separating the phases as much as possible and to make

all parts accessible. The groups of arresters are mounted in such a way that a complete set may be taken out and replaced with the greatest facility, a feature which is believed to be original with this installation.

All overhead lines are provided with knife switches to disconnect them from the substation apparatus.

The high-tension bus compartment is of concrete and is provided with concrete barriers to separate the lines connected to the busses. The series transformers for the measuring instruments pertaining to lines and machines are suspended from the ceiling in a row near the bus compartment, and are separated by barriers. In order to obtain this uniform arrangement, and yet leave the front terminals of the oil switch dead when not in use, the high-tension lines between the series transformers and the power transformers are looped under the bus compartment, an arrangement which affords a very neat and practical way of combining two advantages which hitherto have not been jointly obtained.

The wiring where bare is a copper tubing which gives an excellent mechanical construction, a feature of special importance for the delta of the power transformers. The high-tension bus-bars are supported rigidly, but nevertheless in such a way as to take care of expansion and contraction. All openings in the bus compartment are protected by fireproof doors.

The oil switches are electrically operated and are designed to carry a substantial overload. They are provided with pilot lamps to indicate at the control board whether they are open or closed, and the lamp circuits are so arranged that there is no indication unless the plungers complete their stroke without rebounding. The compartments are of brick which matches the interior of the substations, the barriers between phases being soapstone.

Two substations are equipped with single-phase 550-kilowatt transformers to supply the 1,500-kilowatt converters, whereas the stations with 1,000-kilowatt converters have 375-kilowatt transformers. These have a normal ratio of 11,000 to 460 volts, and are provided with extra taps for varying the voltage according to the drop in the transmission lines, or according to the distribution of load among the substations. They are of the air-cooled type with terminals underneath.

The air is supplied by two induction motor-driven blowers, one of which suffices to supply the station.

The transformers are of the sextuple-connection three-phase type, combining the advantages of the ordinary three-phase and six-phase type. They convert the alternating current at 460 volts into direct current at 666 volts.

These will have motor-operated switches and circuit-breakers, controlled from the boards at the centre of the station. The design of these switches and breakers ensures a certainty, rapidity and safety of action hitherto unknown with this type of apparatus. A spare panel and auxiliary bus are provided to which any feeder or machine may be connected pending repairs on its proper panel. All connections are made with copper bars, thereby ensuring a neat and effective construction.

The positive feeders after leaving the switchboards are provided with end bells which terminate the lead sheathing of the cables which run out to the third rail in underground ducts.

The negative leads from the converters run through the foundations and connect to an ammeter shunt which carries the entire station output. The negative feeders are bare 2,000,000-circular-mil cables which run out directly to the tracks in pipes.

There are two controlling boards situated at a part of the station which will be the centre when the station is extended to its final limits. There is a benchboard which carries the principal instruments and control apparatus, whereas an upright board carries the auxiliary control apparatus for lighting, etc. All panels are of natural slate with black finish, the instrument cases being black oxidized.

Each substation is provided with an electric traveling crane which is also supplied with arrangements for hand operation.

The electric storage battery equipment is believed to be the largest railway battery installation in the world. It not only takes care of load fluctuations but it is sufficiently large to operate the entire system under normal conditions for a period of one hour, in case of failure of generating apparatus. Five of the batteries have an output each of 2,250 amperes for one hour and the others give 3,000, 3,750 and 4,020 amperes respectively.

The batteries are located in buildings adjoining the substations and are operated in connection with boosters and switching apparatus in the substation.

The discharge is governed by a carbon regulator working in connection with exciters and boosters, the effect of which is to make the batteries discharge when there is heavy demand for current and to charge when the demand is light.

The battery houses are of the most modern construction, and have acid-proof floors of vitrified brick. The heating and ventilating systems are of the most approved type and are well protected against acid fumes.

The converters may be started either from the direct-current or alternating-current side. In the latter case a gradual application of voltage is ensured by taking current from several taps in the secondaries of the power transformers. Starting from the direct-current bus, the machine is started as a direct-current motor through a rheostat. When a speed above synchronism is reached, the direct circuits, including the shunt field, are opened, and the machine runs by its momentum only. The alternating current is then put on by closing the oil switch and the machine runs as a synchronous motor. It is then only necessary to close the shunt-field circuit to put the machine in synchronism. These operations are made to follow each other rapidly, and are effected by the use of a special combination switch.

Substation lighting is done with incandescent lamps operated by alternating current at 120 volts. The current is taken from the 460-volt power-circuits and the voltage reduced by special transformers. The lights are distributed so as to illuminate all apparatus and at the same time give a good general illumination. All wiring is in conduit and circuits are controlled from standard panel boxes set in the walls. The lighting of battery rooms has been developed with a view to protection from acid fumes; all wiring in these rooms being lead-covered, and all sockets of porcelain. Emergency lighting current may be taken from the control battery or the charging set.

The direct-current feeder system is designed to give a duplicate path for the current from the substation to the third rail. It is also designed so as to confine any trouble which may occur to one track only, thereby making any interruption of traffic as slight as possible. Switches are provided at the third rail, to disconnect all the feeders at that point in case of a ground between the rail and the station. A train-length section of third rail is sepa-

rately fed from the substation, and is designed to prevent trains bridging between sections. All direct-current cables are installed in tile conduits close to the tracks, except the auxiliary feeders which join the substation busses and supplement the conductivity of the third rail. These are, in some localities, run overhead on the transmission poles.

The four third rails and auxiliary feeder are joined together through circuit-breakers situated in small houses at intervals along the line, thereby increasing the effective conductivity.

An under contact third rail will be used. The rail is of special bull-head section, seventy pounds to the yard, with high electrical conductivity. It is supported by cast-iron brackets bolted to long ties spaced with eleven-foot centres; the insulators fit loosely over the top and web of the rail, thus allowing some vertical play. A clamp fits around the side and top of the insulator and is bolted to the bracket. The top and sides of the third rail will be covered with insulating material to give thorough protection against accidental contact.

The work outlined is under the charge of W. J. Wilgus, vice-president New York Central & Hudson River Railroad. The details described in this article have been worked out under the direction of E. B. Katte, electrical engineer of the system. Messrs. Reed & Stem are the architects for the substations.

The following is a list of the principal contractors:

Transmission-line poles, McClintic-Marshall Construction Company.

Rotary converters for eight substations, Westinghouse Electric and Manufacturing Company.

Storage batteries for eight substations, Electric Storage Battery Company.

Substation No. 1, Butler Brothers Construction Company.

Substations Nos. 2, 3 and 7, Butler Brothers Construction Company.

Lighting and power equipments for the two power stations and substation No. 4, Thompson-Starrett Company.

Eight fifteen-ton traveling cranes for the eight substations, Alfred Box & Company.

Exciter storage batteries for eight substations, Electric Storage Battery Company.

Pintsch gas equipment for the steel suburban cars, the Safety Car Heating and Lighting Company.

The Faraday Society.

The sixteenth ordinary meeting of the Faraday Society was held on Tuesday, October 31, 1905, at the Institution of Electrical Engineers, 92 Victoria street, London, S. W., England. The president, Lord Kelvin, was in the chair.

Professor Ernest Wilson gave a résumé of his paper on "Alternate-Current Electrolysis," which had been taken as read at the previous meeting.

Table I—Experiments (Roy. Soc. Proc., vol. liv, p. 407) made with platinum plates in dilute sulphuric acid show that of the total energy supplied to the cell in a given time, more is returned to the source when the frequency is high than when it is low—the maximum coulombs being of the order 0.0006 per square centimetre in each case. If the quantity of electricity be plotted coordinately with the electromotive force of electrolysis it is found that at the higher frequency, for about the same maximum coulombs, the curve has relatively a smaller area, such reduction being probably brought about by the greater reversibility. An experiment made at an intermediate frequency when the maximum coulombs were 0.0000023 per square centimetre gave a still higher value for the proportion of the total energy which is returned to the source—demonstrating that the magnitude of the maximum coulombs has an important effect.

Further experiments (Ibid., vol. lxiii, p. 346) made with aluminum plates in dilute potash, soda, and ammonia-alum solution showed a similar effect.

Table II—Judging from the above experiments, one might be led to expect that when a metal is dissolved in an electrolyte by alternate-current electrolysis, the amount dissolved in a given time at a given current density would be smaller at high than at low frequency. This is found to be the case as the experiments in the present paper (Faraday Soc. Trans., vol. i, August, 1905) show.

Table III—Besides this chief conclusion there remain indications of other important effects. So great is the number of variables, and so great the difficulty of keeping all but one constant during an experiment, that from the few experiments performed it is dangerous to attempt a generalization.

All the experiments in table III were made at frequency 92. The weight of lead dissolved in dilute H_2SO_4 increases with the current density. Amalgamated zinc is difficult to deal with as the degree of amalgamation influences the result. Iron is dissolved in ferrous-sulphate at a greater rate the greater the current density when the respective experiments are

TABLE I—INFLUENCE OF FREQUENCY ON ELECTROLYTIC ACTION.

Metal.	Electrolyte.	Frequency.	Percentage of Total Energy Returned	Max. Amperes per Square Centimetre.	Max. Coulombs per Square Centimetre in. 10^{-3}.	Max. Volts Across Cell.	Max. Volts of Electrolysis.		Remarks.
							O_2	H_2	
Platinum	Dilute H_2SO_4	142.5	40.8	.436	.474	1.77	.78	.68	Correction made for conductivity.
"	" "	2.4	13.6	.013	.800	1.37	.72	.66	
"	" "	88.7	2.54	.0018	.00226	0.50	..	..	
Aluminum	Soda alum dilute	42.2	26.0	.0042	....	35.0	....		Correction not made for conductivity.
"		10.5	3.2	.0032	....	31.3	....		
"	Ammonium alum dilute	41.3	22.0	.0042	....	47.6	....		
"		10.5	4.0	.0032	....	49.1	....		
"	Potash alum dilute	41.3	14.0	.0042	....	45.0	....		
"		10.5	2.6	.0032	....	44 4	....		

TABLE II—INFLUENCE OF FREQUENCY UPON ELECTROLYTIC ACTION.

Exp.	Metal.	Electrolyte.	Milligrammes per Hour per Square Centimetre.	Frequency.	R M S Amperes per Square Centimetre.
1	Lead	Dilute H_2SO_4	6.29	21.5	.0236
2	"	" "	3.44	92.5	.0236
4	Zinc	" "	5.30	25.5	.024
8	Amalgamated	" "	3.37	32.0	.031
5	"	" "	1.89	92.0	.025
17	Iron	Strong ferrous sulphate	0.787	32.0	.034
13	"		0.462	92.0	.027
20	"	Strong sodium chloride	0.100	32.0	.031
18	"		0.017	92.0	.026
14	Copper	Strong sodium chloride	0.278	32.0	.034
23	"		0.028	92.0	.024

started with fresh solutions. This is not the case when a new experiment is started in a solution whose density has been increased by electrolytic action in a previous experiment. Compare experiments 13, 14, 16. A difficulty with ferrous-sulphate solution is its known tendency to oxidize. In sodium chloride more iron is dissolved at the higher current density. A complete investigation would need to take accounts of the density and temperature of the electrolyte, and possibly of other conditions.

Mr. W. R. Cooper read an abstract of his paper on "Alternate-Current Electrolysis as Shown by Oscillograph Records," illustrating his remarks by projecting on the screen a selection of his photographic records.

It is pointed out that although polarization is of the nature of capacity in an alternate-current circuit, there is a considerable difference. What might be termed the electromotive force of a condenser rises and falls as rapidly as the applied pressure, but although the electromotive force of polarization may rise as rapidly as the applied pressure, it falls more slowly, with the result that under suitable conditions the current curve may depart very considerably from the sine form. Actual oscillograph records are reproduced in support of this view. In considering the subject it has been very generally assumed that the current follows a sine curve. Since the curve obtained depends very much on the conditions of the experiment it is necessary to define the conditions very carefully before conclusions can be drawn from different experiments. Oscillograph records of electrolytic rectification were also shown.

TABLE III—INFLUENCE OF CURRENT DENSITY UPON ALTERNATE-CURRENT ELECTROLYSIS.

Exp.	Metal.	Electrolyte.	Milligrammes per Hour per Square Centimetre.	R M S Amperes per Square Centimetre.
2	Lead	Dilute H_2SO_4	3.44	.0236
3	"	" "	32.3	.0847
5	Zinc	" "	1.89	.0253
6	"	" "	6.95	.0923 *
7	"	" "	1.66	.0889
13	Iron	Strong ferrous sulphate	0.462	.0273
14	"	" " "	0.457	.0979 †
16	"	" " "	4.45	.0929
18	"	Strong sodium chloride	+ 0.017	.0262
19	"	" " "	+ 0.121	.0929

* Same solution and plates as in experiment 5. † Same solution as used in experiment 13.

Mr. A. E. Trotter referred to the bearing of work on alternate-current electrolysis on the corrosion of water and gas pipes caused by stray currents from alternate-current systems. He described some practical experiments he had made with lead pipes buried in the earth; these experiments showed that there was a minimum current density or a minimum voltage—he was not sure which—below which no corrosion took place. More work was required to be done in order to indicate the exact conditions necessary for corrosion, but great caution was necessary in the application of scientific experiments to practice.

Mr. J. Swinburne thought that the greater absorption of energy found by Professor Wilson at the lower frequencies was simply due to diffusion, and this was borne out by Mr. Cooper's curves.

Dr. F. Mollwo Perkin said he had found that platinum plates electrolyzed alternately in dilute sulphuric acid were more corroded at low than at high frequencies; a colloidal solution of platinum seemed to form, and the electrodes had an etched appearance.

Professor A. K. Huntington contributed a "Note on the Crystalline Structure of Electrodeposited Copper," which was illustrated by photomicrographs of sections of the deposits referred to in the paper.

In Mr. Cowper-Coles's process for making copper wire electrolytically a spiral scratch or groove on the mandril causes the copper deposited on it to part so easily that a long ribbon can be obtained. The author's explanation is that the direction of the lines of crystallization of an electrodeposited metal are the same as in a casting made on surfaces having the same inclination, *i. e.*, the crystals form at right angles to the surface on which the deposit or the casting is made. It follows that when the crystals which form on surfaces more or less at an angle to one another meet, there will be want of continuity in the two sets of crystals, and a line of weakness will be developed. Therefore in castings and deposits when strength and not rupture is aimed at, it is important to avoid sharp angles. In the case of a cathode plate which has been deposited on a thin strip of electrodeposited copper the crystals of the original strip continued in some cases in the cathode plate. On annealing the electrodeposited copper the long crystals of the deposit are completely broken up and become largely twinned. Hence brittleness due to the direction in which crystals form in castings and electrodeposits may be modified and probably completely removed by suitable annealing, unless the continuity is entirely broken.

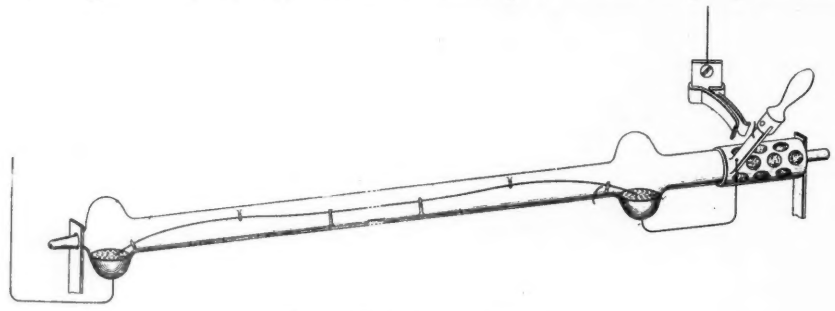
Mr. J. F. R. Rhodin thought that structure of the copper deposited in a groove, such as Mr. Cowper-Coles employed, depended on electrostatic repulsion rather than on crystalline form. The fringing at the edge of a deposit, even where the current density was not high, seemed to him to confirm that explanation.

Mr. W. Pollard Digby's paper on "Some Observations Respecting the Relation of Stability to Electrochemical Efficiency in Hypochlorite Production" was taken as read.

The author commenced by drawing attention to the fact that in all electrolytic methods of producing hypochlorite solutions, only a small portion, rarely more than eighteen per cent of the chlorine usually present in the form of chloride, is converted into hypochlorite, and suggests that the amount of available chlorine produced from a sodium chloride solution depends upon the relation which the amount of unconverted sodium chloride actually present between the electrodes bears to the current density. As regards stability, particulars are given of two tests in which the rate of depreciation, although only 0.3 to 0.4 gramme in twelve hours per litre for solutions containing eight grammes of available chlorine per litre, caused a very great depreciation in the yield per kilowatt-hour supplied. The suggestion is advanced that no test of the efficiency of any apparatus for the electrolytic production of the hypochlorites can be regarded as complete without an estimation of the losses through instability, and a mention of the volume of the contents of the electrolyzing tank. While stability of solution does not greatly affect the efficiency of any continuous type of apparatus (in which the sodium chloride is fed in at one end and drawn off at the other end ready for continuous use), it will materially affect the efficiency in any non-continuous apparatus or in any apparatus in which the electrolyte is circulated through an external cooling tank and returned to the electrolyzer to be further worked up. It is suggested that the presence of minute quantities of iron in the solution have also a bearing on the depreciation.

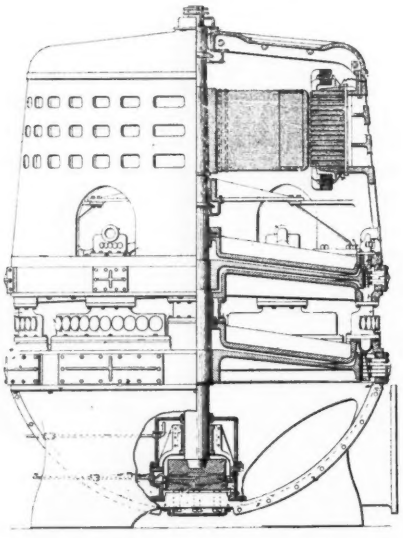
Electrical Patents.

Alexander D. Lunt, Schenectady, N. Y., has assigned to the General Electric Company a patent granted to him on a vapor electric apparatus (803,836), November 7, 1905). The invention relates to means for starting vapor electric devices, such, for example, as mercury-vapor lamps, rectifiers, or the like. In carrying the invention into practice, electrodes are provided which before the device is started are electrically connected by a conducting member. In the operation of starting, this member, by movement of the apparatus, either of rotation or otherwise, is disconnected from the two electrodes, whereby the initial arc thus produced operates to start the flow of current between the electrodes.



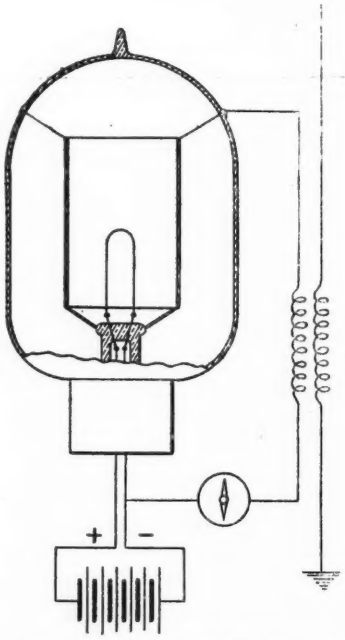
Vapor Electric Apparatus.

An improved turbine has been patented by William L. R. Emmet, of Schenectady, N. Y., and the patent obtained thereon has been assigned to the General Electric Company, Schenectady (803,678, November 7, 1905). The object of the invention is to improve and simplify the construction of elastic-fluid turbines and also to make them more efficient. In carrying out the invention the shaft is mounted in a vertical position and rigidly attached thereto are the bucket-wheels and also the revolving member of a dynamo-electric machine. The vertical arrangement is highly advantageous in that the tendency of the shaft to spring and cause the wheel-buckets to rub on the stationary parts is overcome. It also overcomes a difficulty in loading the several bearings evenly. The shaft and bearings can also be made shorter for a given size machine, because the weight is supported by a step or thrust bearing, the other bearing or bearings merely acting as guides, which do not carry weight. In other words, the pressure is removed from all of the bearings except the step or thrust bearing.



Improvement in Steam Turbine.

John A. Fleming, of London, England, has patented in this country an instrument for converting alternating electric currents into continuous currents, and has assigned the entire interest in his invention to the Marconi Wireless Telegraph Company, of New Jersey (803,684, November 7, 1905). The invention is especially designed for converting high-frequency alternating electric currents or electric oscillations into continuous electric currents for the purpose of making them detectable by and measurable with ordinary direct-current instruments, such as a "mirror-galvanometer" of the usual type or any ordinary direct-current ammeter. Mr. Fleming has discovered that if two conductors are enclosed in a vessel in which a good vacuum is made, one being heated to a high temperature, the space between the hot and cold conductors possesses a unilateral electric conductivity, and negative electricity can pass from the hot conductor to the cold conductor, but not in the reverse direction. As the hot conductor should be heated to a very high temperature, say near to the melting-point of platinum (1,700 degrees centigrade), it should be of carbon, preferably in the form of a filament such as is used in any ordinary incandescent lamp. The cold conductor may be of many materials, but a bright metal is preferred, such as platinum or aluminum or else carbon. The two conductors are enclosed in a glass bulb similar to that of an incandescent lamp, and the carbon is generally heated to a high state of incandescence by a continuous electric current, the electrical connection to the filament and the cold conductor being made by platinum wires, sealed air-tight through the glass.



Alternating-Current Rectifier.

Three-Phase, Direct-Current Car Equipment.

At the recent electrical exhibition in London, Bruce, Peebles & Company, Limited, London, exhibited a unique traction equipment constructed for the Canadian Southwestern Traction Company, of London, Ontario. The peculiar feature of this equipment is its adaptation to operation over either a direct-current system or a three-phase system. The following description is taken from the *Electrical Review* (London):

The motors are of 135 horse-power each. The car is intended for operation over a thirty-mile interurban line. This line is supplied with three-phase currents at 1,100 volts, except in the town of London, where the cars operate over 500-volt, direct-current lines. The motors have a distributed winding, and an armature with commutator and slip-rings. The winding is similar to that of a series direct-current motor upon the two-circuit principle. On the direct-current circuit the motors are controlled in the standard way. On the alternating-current circuit the brushes are lifted off the commutators, and the motors are started in cascade, and then cut in parallel.

LETTERS TO THE EDITOR.

The Seattle-Sitka Cable.

To the Editor of the Electrical Review:

On page 742 of your issue for November 11, 1905, in the latter part of your article on submarine-cable notes, it appears that your journal has, inadvertently, no doubt, given further circulation to an article originally appearing in one of the western papers, in which it is stated that the Seattle-Sitka cable has virtually failed, entailing loss of communication, and a large waste of money on the part of the government.

This mass of falsehoods seems to have more vitality than is usual in such cases, and it is felt that your journal, in its hitherto fair treatment of the signal corps of the army, will give at least equal prominence to the refutation of this statement.

It was deemed expedient by the chief signal officer of the army last month to order the Burnside to remove a couple of obscure faults which had developed in the cable in the strait of San Juan del Fuca, near Cape Flattery. This was done promptly by the cableship Burnside, the faults remedied, and the cable is now in perfect working order. The only interruption to the cable was during a few days while the cableship was working on it.

It does not seem to have occurred to the critics that no means has yet been discovered for repairing a submarine cable without temporarily interrupting it.

This office is quite at a loss to understand the reason for the adverse comments on the work of the signal corps from sources which, instead of blaming, should feel under many obligations to the government for incidentally furnishing them with easy commercial communication with our northern possessions.

A. W. Greely,
Brigadier-General.
Chief Signal Officer of the Army.
Washington, D. C., November 14.

The Rating of Incandescent Lamps.

To the Editor of the Electrical Review:

In your issue of October 28 there is a communication from Mr. J. C. Fish, of the Shelby Electric Company, Shelby, Ohio, concerning the rating of incandescent lamps. As he states in his letter, Mr. Fish has been conducting a campaign of public education for the past six years; indirectly, in the matter of the importance of considering illuminating results as well as the mere production of light, and directly, in the way of showing the inadequacy of the prevailing method of rating incandescent lamps. His position in these matters has usually been so sound, that it seems a pity he should at this late day stray away from the logical path that he has so long followed, for it seems to me that he is decidedly astray on a number of the points which he makes in his letter. The method of rating a lamp by its intensity in one direction only is, as he says, now considered erroneous by all thinking people; but his contention that "the use of the mean spherical measurement in place of this would be practically as bad," will not stand the test of reason. The only method of comparing the efficiency and workmanship of different styles and makes of incandescent lamps is by means of their mean spherical candle-power. The question of the natural distribution of the light of a given source, and the modifications possible by the use of reflectors and globes, is one which concerns the user, and constitutes one of the most important questions in illuminating engineering. There are cases in which it is inexpedient to use any accessory about a lamp, and in this case the natural distribution of the lamp is of prime importance; but where an accessory, such as a globe or reflector, may be used without difficulty, the natural distribution of the light loses most of its importance, since it is possible to redirect the light in practically any manner desired. The fact should furthermore not be lost sight of, that incandescent lamps, no matter how their distribution may vary in other respects, divide their total flux of light equally between the upper and lower hemispheres.

His point in regard to the searchlight is not well taken. The searchlight is simply an electric arc fitted with a special reflector; and in comparing the efficiencies or illuminating values of searchlights, the correct method, and the one actually used, is based upon the mean spherical candle-power of the arcs without the reflectors. The use of this particular reflector, which converts the electric arc into a searchlight, is simply for the reason that a parallel beam of light is required; if the light were required to be used in some other manner, as for general illumination, a different kind of reflector would be used, and similarly in the use of the incandescent lamp.

Mr. Fish is again in error in stating that "one of the largest manufacturers, calling attention to certain very efficient light units, does not make any claims to the horizontal distribution, but claims an efficiency of two and one-half watts per candle-power"; and that "it is a remarkable fact that this particular light unit does not deliver light in any direction at the efficiency of two and one-half watts, which is the efficiency claimed." In the rating of this unit, the lamp itself is measured and rated in the usual manner; that is, by mean horizontal intensity, and it is by this measurement that the lamp is two and one-half watts efficiency. The effect of the reflector is very properly not taken into consideration in rating the lamp.

His suggestion that the use of a reflector "only changes the direction in which the light is wasted," is also fallacious. If, by the use of a reflector, the downward light is found to be of so high a degree of intensity as to be "ruinous to the eyes," as Mr. Fish maintains, the remedy of simply using a lower candle-power lamp, requiring less current, is easily applied.

In conclusion I would submit this proposition as entirely logical: all light sources should be rated in a uniform manner, which will show their efficiencies as light producers, and which will enable comparisons to be made between them on a uniform basis. Their comparative mean spherical candle-powers furnish these data.

E. Leavenworth Elliott.
New York, November 17.

Arrangement of a Braun Tube for Producing Cathode Rays Having a Low Velocity.

Dr. A. Wehnelt has recently described a type of Braun tube which he has developed in order to obtain cathode rays having a low velocity, and therefore strongly deflected by electric and magnetic fields. The cathode ray proceeds from a cathode consisting of a small strip of platinum maintained hot by means of a current passed through it. Upon this cathode is a small spot of calcium oxide or the oxide of some other earth. In front of the cathode, axially along the tube, is a screen pierced by a small hole. Beyond this is a space where the electric and magnetic fields may be set up, and still further on is the phosphorescing screen. The cathode is connected to the negative terminal of a source of high potential, and the screen to the positive. The former is maintained at a dull red heat, and under these conditions throws out a brilliant white cathode ray, which is cut down to the required narrow pencil by means of the screen. The low velocity of this ray enables it to be used very conveniently for investigating electric and magnetic fields, as an oscillograph, and for other purposes.—*Physikalische Zeitschrift (Leipsic), November 1.*

Reviews of Current Engineering and Scientific Literature.

An Electrometer for the Stage of a Microscope.

Mr. W. T. Porter describes in this article a simple and convenient type of capillary electrometer for use on the stage of a microscope. The electrometer consists of three parts: a glass tube, the lower end of which is drawn into a capillary; a second glass tube containing the acid solution into which the capillary dips; and a small cylinder with a movable piston for applying pressure to the upper surface of the meniscus. The end of the capillary tube is drawn out into a fine capillary, which is dipped into a twenty per cent solution of sulphuric acid. Platinum electrodes are introduced, one into this tube, and one through the bottom of the acid tube. A small quantity of pure mercury is introduced into the capillary tube, and by means of the movable piston is forced down through this tube until a small drop is ejected through the lower end. The pressure is then reduced slightly, allowing the mercury to reascend in the capillary and draw the acid with it. This electrometer is very sensitive, and should not be exposed to differences of potential exceeding one-tenth volt. When not in use, it should be short-circuited by a switch connecting the terminal wires, so as to maintain the two contact surfaces at the same potential. In use, the shifting of the meniscus may be taken as the measure of the electromotive force being investigated, or the meniscus may be kept at a fixed position, the electromotive force being read by the change in pressure in the pressure-cylinder required for this purpose. It is convenient to fill this cylinder with a heavy oil. The advantages of this type of electrometer are that it can be used with the microscope in a convenient position; it is accurate and easily calibrated, but it must be recalibrated frequently, since there is a tendency for the meniscus to drift.—*Abstracted from Science (Lancaster), November 10.*

The Use of Condensers for the Continuous Operation of Three-Phase Motors.

A method employing condensers and reactance coils, so as to enable a three-phase motor to be run satisfactorily from a single-phase circuit, is here described by Herr J. Dalemont. The method consists in bridging across a supply circuit a condenser and a reactance coil in series, and in connecting one coil of the delta-connected motor across the circuit, and the junction of the other two coils to the point intermediate between the condenser and the reactance coil. By the proper adjustment of capacity and reactance, a satisfactory displacement of the phase of the currents in the coils of the motor is obtained. The machine may be run thus continuously. The conditions, however, do not exactly correspond to those of a three-phase motor on a three-phase circuit, but they can be made more nearly so by reversing the connections of the coil which is placed across the supply circuit. The author discusses first the theory of this method of operation, and then gives the results of tests of a motor operated first normally as a three-phase motor, then connected as first suggested across a single-phase circuit, and lastly with one coil reversed as mentioned. Operating as a three-phase motor, the machine with an output of fifty-five watts had an efficiency of fifty-eight per cent and a power-factor of eighty. With the motor connected to the coil unreversed, at the output of 300 watts the efficiency was forty-two per cent, and the power-factor eighty-eight. Connected with the reversed coil, and with an output of 450 watts, the efficiency was fifty-five per cent and the power-factor ninety-one. The points in operation which have been quoted are those for the maximum efficiency for each method of running. It is suggested that this method might be used for operating three-phase motors on a single-phase railway circuit when such operation seems desirable.—*Translated and abstracted from Elektrotechnische Zeitschrift (Berlin), November 2.*

Widnes-Runcorn, England, Electric Transporter Bridge.

A traveling ferry bridge has been erected across the river Mersey, between Widnes and Runcorn, England, which is operated by electric motors. The bridge itself is of the stiffened suspension type, with two main girders at a height of eighty-two feet above high water. The span of the bridge is 1,000 feet. On these girders runs a trolley, from which the traveling platform is suspended by steel-wire ropes. The platform is capable of accommodating 300 foot passengers and four two-horse wagons. The time occupied in making a trip is two and one-quarter minutes. The trolley is carried on thirty-two wheels, sixteen of which run on each rail. It is driven by motors mounted in the centre of the trolley, which receive power from the generating station on the bank. This power-house is on the Widnes side of the river, and contains two Crossley gas engines, each rated at seventy-five brake-horse-power. They run at 210 revolutions per minute, drawing gas from the town mains. Each engine is directly coupled to a forty-eight-kilowatt multipolar dynamo, giving a continuous output of ninety amperes at 525 volts. The engine room also contains a booster, consisting of a motor and generator directly coupled, which is used for charging the accumulators and regulating their output. The accumulator consists of 245 cells, with a capacity of ninety amperes for one hour. The batteries are set up in a room over the engine room. From the switchboard two main supply cables are led up one tower, and across to the main girders of the bridge, where they are attached to two overhead T-shaped conductors carried by insulators below the cross girders of the bridge. From these conductors the current is collected by trolley arms, and passes down through the driver's cabin, which is placed on top of the traveling car, through the controlling devices, then to the motors. The motors are of the semi-enclosed type. There are two of these, rated at thirty brake-horse-power each. They drive, by means of gearing and shafts, the wheels of the trolleys.—*Abstracted from the Electrical Review (London), October 20.*

The General Care of Storage Batteries.

In this article by Mr. J. Lester Woodbridge, on electric storage battery engineering, the author describes the general methods of installing and operating batteries, and closes with some interesting remarks upon their care and maintenance. The amount of attention which a battery requires is comparatively small, but it is important. The electrolyte must be kept above the top of the plates by the addition of pure water from time to time, to replace evaporation. Prolonged and repeated overcharging must be avoided, but it is desirable to overcharge the battery slightly about once a week, the charging current being continued for about an hour after the maximum specific gravity is reached. Over-

discharging should be avoided in regular service. The battery should not be allowed to stand for a considerable length of time in a discharged condition, but should be recharged as soon as practicable. This applies not only to the battery as a whole, but to the individual cells. If some of the cells, by reason of an accidental short-circuit, become discharged, the cause should be removed as promptly as possible, and the cells brought back to their proper state. A slight or partial short-circuit may occur by the lodging of foreign matter between the plates in a cell. This will gradually bring the cell to a lower state of charge than the others in the battery. To detect cases of this kind it is advisable to take specific gravity readings of all the cells once a week. If these readings show that a cell has fallen off below the others, the cause should be sought out and removed. Usually the weekly overcharging will bring the cell to its normal state of charge. A recording voltmeter, which will give a continuous record of the voltage at the battery terminal, is of great assistance in ensuring the proper handling of the battery. This will show the character of the service to which the battery has been subjected, and whether the charge has been stopped at the right time; and by giving the average at the battery terminals for each of the twenty-four hours, will enable the operator to determine whether the battery is being overcharged, or the reverse.—*Abstracted from Cassier's Magazine (New York), November.*

Some Tests on Lamp Globes.

Some interesting tests on lamp globes used in connection with the Nernst lamp are given here by Mr. Maurice Solomon. The tests were made some time ago, and have not been verified, but they seem to the author to be of particular interest. He found that the correction factors usually employed for globes of different descriptions did not apply at all to his work; in fact, a plain glass globe, although it is usually said to decrease the amount of useful light by ten to fifteen per cent, actually increased the light by from one to three and one-half per cent, the increase being due to the higher temperature at which the enclosed filament was maintained. Similar results were obtained with frosted globes, which caused a loss of only two to six per cent, although they are generally thought to decrease the amount of light by fifteen to thirty per cent. The results are believed to be accurate within two per cent. The author then describes a simple method of obtaining mean spherical candle-power of a lamp of this kind. The distribution of light in three planes was measured: the horizontal, the vertical plane through the filament, and the vertical plane at right angles to the filament. From these data distribution curves for the three planes are plotted. As the Nernst filament is a straight rod, the horizontal distribution may be divided into four similar quadrants, so that it is only necessary to consider the distribution in one of these. The values obtained for the three planes are plotted to rectangular coordinates, the abscissa representing angles made with the axis of the filament, and the ordinates, candle-powers. The mean height of ordinate of any one of these curves will be the average value of candle-power in that particular plane. If a sphere be described around the source of light, and be divided into a number of horizontal zones, the mean spherical candle-power can be obtained by Rousseau's method, if the mean intensity of light in each zone be known. But these values can be obtained approximately from the three sets of readings taken above, as follows: the distribution of light for a cone having a vertical angle of zero degrees is obviously a circle, and is hence represented on the curve sheet by a straight line. The distribution for the horizontal plane has already been determined, and it is obvious that the distribution in the planes lying between these two will vary in a continuous manner, so that curves may be drawn between the two curves already plotted by starting and ending with the values which have already been determined for the two vertical planes, and drawing the lines so that they change gradually from a straight line to the form found for the distribution in the horizontal plane. From these lines the mean spherical candle-power can be computed by measuring the areas included. The value is believed by the author to be fairly accurate.—*Abstracted from the Electrician (London), November 3.*

Novel Features of Communication on the Steamship Amerika.

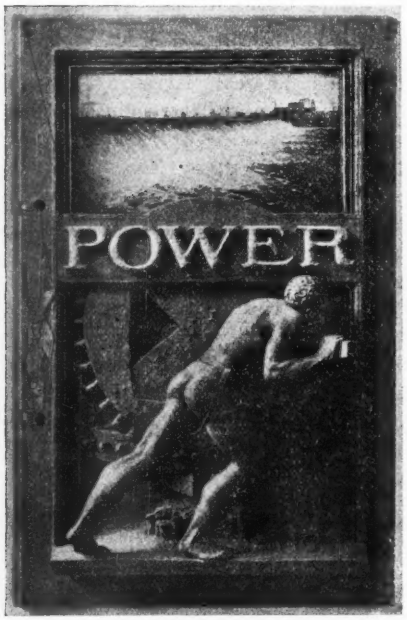
There are four separate telephone systems on the steamship Amerika, the newest addition to the fleet of the Hamburg-American Line. These systems are described in this article by Mr. Edward A. Tyler. Together they form the most complete means of communication which has ever been installed upon shipboard. The one of these in which the public will be most interested is a system for communicating from the staterooms to the stewards and to other staterooms. The instruments are placed in certain of the staterooms, there being about 100 in all. They connect with three branch switching points in charge of attendants, and are intended mainly for communication with the stewards. They can, however, be connected to a main distributing board at the bureau of information, and from here to any other stateroom telephone. Should a call come to any switching point when the attendant is not there, a signal is given to the information clerk, who despatches a messenger to answer the call. The stewards' telephone system is separate and distinct from the stateroom equipment. It connects at each of the branch exchanges, and also with the kitchens, pantries and similar locations. This is a single-line system, with five bridged stations. The navigating and engineering department has a third system, which consists of instruments of the loud-speaking naval type, connected between the different navigating stations, the engine room and the engineer's office. In all there are twelve of these, distributed at various points on the boat, to be used by the officers in charge, and by the watches. The fourth system is used in connection with submarine signaling. The receiving instruments are placed well forward in the bow of the boat, inside the hold, one on each side of the vessel below the water line. This apparatus is used to locate the position of submarine signal bells installed at the entrance to harbors or on dangerous reefs. The telephone installation, as a whole, represents European practice rather than American. An important feature is the use of the telephone to increase the efficiency of the personal services offered the passengers, and to transmit orders and receive replies. Until recently the telephone has been considered rather unreliable for this work. The installation on the Amerika will probably do much toward removing this feeling, since it is equivalent to the admission of the superiority of the telephone for transmitting information and receiving instructions which effect the control of the movements of the ship. The system has been installed with much care. No wires smaller than No. 18 Birmingham wire gauge have been used. The conductors are insulated with gutta-percha, and where possible are combined into a lead-covered cable. This sheath is protected by a durable, weatherproof braided covering.—*Abstracted from the American Telephone Journal (New York), November 4.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

"The South Bend Electric Company and the Elkhart Electric Company control the power output of the St. Joseph & Elkhart Power Company, the Buchanan Company, and relay steam plants at South Bend and Elkhart, Ind."

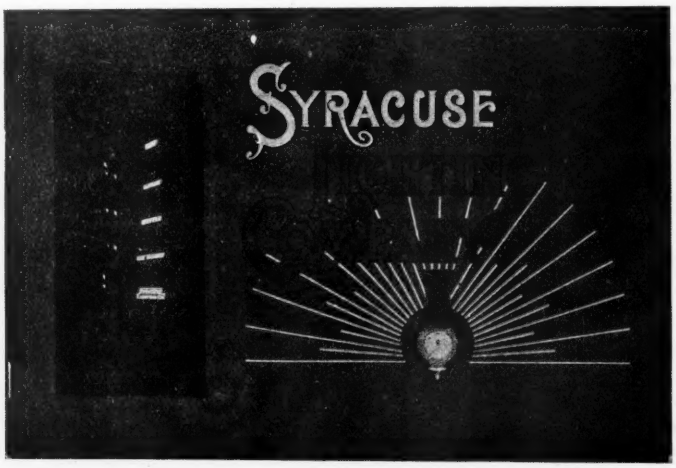
Such is the opening paragraph of a very handsome brochure which has been developed by the above-named companies. The salutation is as follows: "Mr. Business Man: If you are interested in an economical machine drive—say, power that can be produced at forty per cent below the



cost of power produced by coal—this book will interest you. To convince you that reliable power can be acquired at the saving mentioned, the resources in power of the South Bend Electric and Elkhart Electric companies are here explained." Concrete examples of factories using this power are given, followed by the commercial points of interest in the district in which the power is sold.

The book comprises thirty-two pages and the cover. In addition to the two-color printing on the soft buff paper, there are two half-tone illustrations on every page. These illustrations portray various buildings in and about the city wherein power is used, and various machines which are driven by means of electric motors.

In any analysis of the methods in vogue for stimulating the demand for electric current for any service, no other material is so valuable as a basis as is the experience of some institution which has tried out various methods, with varying degrees of success. One of the most successful of the modern public service corporations is the Syracuse Lighting Company, of Syracuse, N. Y. This company has made a very extensive use of modern methods of publicity, under the direction of Mr. William B. Ross, of the lighting and power department. Some four years ago this company's power business amounted to a little over 600 horse-power. To-day it is nearing the 5,000-horse-power mark, and is steadily increasing. Its lighting load has kept steadily apace, and comparing output with population, the current delivered forms a very respectable percentage of the total amount of energy of any nature used for illumination. The company not only uses a considerable amount of advertising matter, but keeps itself constantly before the public by personal interviews. In order to first reach the public, a carefully prepared circular letter was sent to a selected list. This letter was forwarded to each and every industry, calling attention to the particular machines in use by the individual or company. This was followed by an interview, showing the best methods of installation, and pointing out the advantages to be derived. Later on a booklet, handsomely illustrated and represented in very attractive form, was distributed. An illustration of the cover of this booklet, which is in pearl and gold, is given herewith. In addition to this, at a large expense the company fitted up a display room, where practical demonstrations of the various apparatus were given. It is safe to say that this room has paid for itself over and over again.



Nearly every month the company encloses with its monthly bills some literature obtaining to some part of its business. For instance, heating and cooking apparatus, special lamps, small motor possibilities, etc., are kept constantly in the minds of the public in some shape or other. The company has a large lamp board in its display room, showing almost every lamp manufactured, and many special lamps are sold in this way. As a rule, the general public has become accustomed to the commercial lamp, and has not in mind many specialties, such, for instance, as Turkish corners and other uses to which these lamps can be put for decorative effects. The demonstrations undertaken by the Syracuse company have done much to create new uses for electric lamps throughout the city.

The company carries out all of its advertising propositions according to a definite campaign. But little advertising is done in the daily newspapers. No inside wiring is undertaken, the company bringing its wires to a point of entrance,

the local contractors doing all interior wiring at the expense of the owner or consumer. The first installation of the lamps has to be paid for; after this the company gives free lamp renewals on commercial lamps. For special lamps a charge is made covering the difference between the cost of these and the cost of the commercial lamp.

The company has a regularly organized complaint department which receives complaints and turns these over to the proper party for investigation.

The company follows up all enquiries concerning either new business, extensions or complaints by personal interview and by correspondence from special departments. The endeavor is always made to settle all complaints by personal contact with the aggrieved party, and everything is done to win the confidence of the public by securing its good will. To do this the company must show a mastery of its business, and in every way nothing is avoided that will command the respect of the consumer. In securing this, great attention is paid to the selection of the representatives of the company, who by frank dealing and personal contact make the best impression on the consumer.

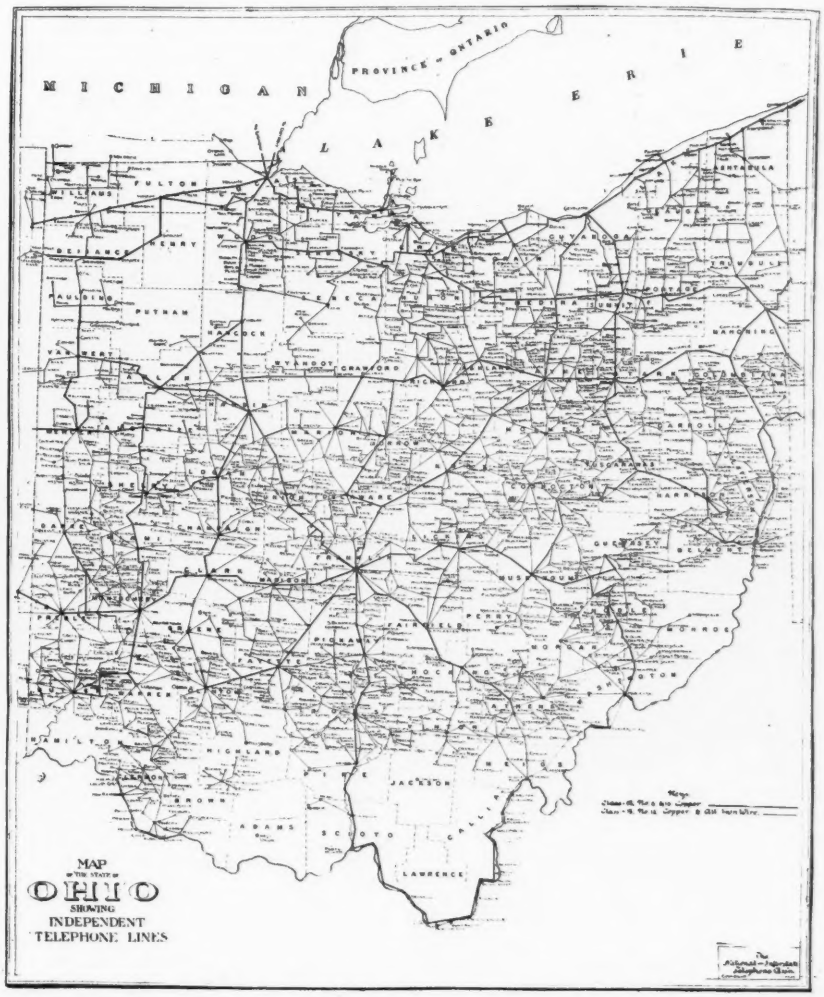
Madison Square Garden Electrical Show.

The list of exhibitors at the Madison Square Garden electrical show, to be held December 12 to 23, has already reached gratifying proportions, and new contracts are said to be coming in very rapidly. The following firms have already definitely selected spaces and signed contracts for exhibits:

National Carbon Company, Joseph Goldfinger, Eastern Carbon Works, *American Telephone Journal,* Thos. M. St. John, G. M. Gest, Magneta Clock Company, Peerless Electric Company, Magnet Wire Company, Waterbury Company, Electro-Dynamic Company, Gray National Telautograph Company, General Storage Battery Company, Natural Food Company, Stow Manufacturing Company, Chicago Pneumatic Tool Company, Vandyck-Churchill Company, Gold Car Heating and Lighting Company, New York Telephone Company, William Krug, Standard Vitrified Conduit Company, Niagara Tachometer and Instrument Company, National Battery Company, Clark Electric and Manufacturing Company, National Meter Company, *Electric Journal, Engineering News,* Douglass Manufacturing Company, International Correspondence Schools, Brunswick Refrigerating Company, Electro-Radiation Company, Simplex Electric Heating Company, American De Forest Wireless Telegraph Company, Mohican Spring Company, Wireless Railway Company, Burke Electric Company, George L. Mason Company, *Electrical Age,* Waite & Bartlett, Ovington Manufacturing Company, Kinsman Block Signal System, Kinsman Electric Railway Supply Company, Veedee Vibrator Company, Victor Talking Machine Company.

A Preliminary Map of the Independent Telephone Lines of Ohio.

The accompanying illustration shows a preliminary map giving about three-quarters of the independent telephone lines of Ohio. Much work is being done by the National-Interstate Telephone Association to secure authentic material relative to the independent telephone systems throughout the country. Considerable data for lines not shown have been received since tracing this map, and a later edition will be issued, showing all the lines about which it has been possible to secure information.



A Preliminary Map, Showing About Seventy-five Per Cent of the Independent Telephone Lines in Ohio.

Independent Telephone Systems in Indiana.

The tax returns of 228 companies in eighty-four counties reporting to the auditor of the state of Indiana for 1905, with the remaining companies estimated on the same basis, show a total investment of $11,605,873, an increase of $3,897,242 over 1904. Gross earnings for 1905 were $3,500,000, a gain of $778,000 over those of 1904. Improvements to the amount of $112,846 were paid out of the earnings, this amount being $42,117 more than in 1904. The actual gain in net earnings as compared with 1904 was $313,042. The total number of independent telephones in the state at the present time is about 175,000. This development has been achieved within six years, and the 368 independent exchanges in the state are reported to be doing a good business.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Automatic Switchless Telephone.

The DeVeau Telephone Manufacturing Company, New York city, has perfected the design of an automatic switchless telephone with exchange connection and other improvements.

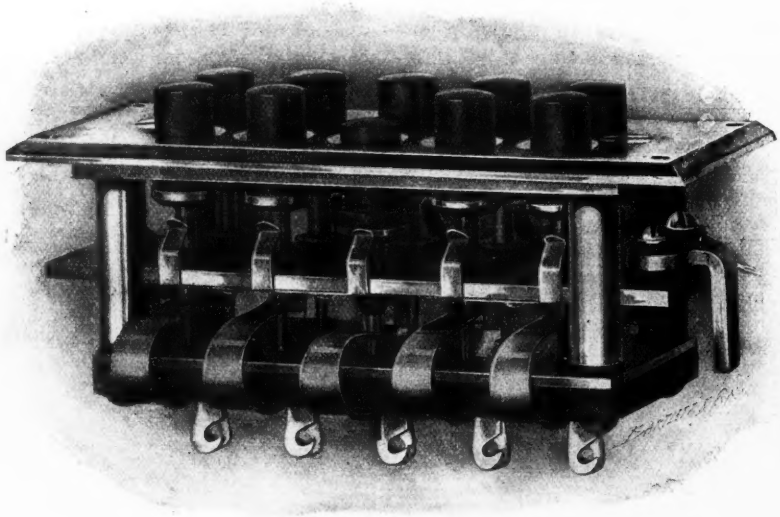


FIG. 1.—MECHANISM OF AUTOMATIC SWITCHLESS TELEPHONE APPARATUS.

The mechanism illustrated in Fig. 1 is a built-up frame of heavy sawed brass with a sliding plate in the centre. The push-buttons are made of hard-drawn, cone-shaped brass, with a hard-steel pin on one end and a hard-rubber button on the other. There are no spiral springs used in the mechanism. The buttons are held and worked by heavy hard-drawn bronze springs bent on one end for the line terminal. Pressing the button all the way in will give the ringing circuit. On its return the button makes two self-cleaning talking contacts. When through talking, the receiver is placed on the hook, releasing the button.

Careful attention has been given to the ringing contacts and the talking contacts. The self-cleaning feature eliminates the ordinary corrosion due to the deposits of dust or other foreign substances.

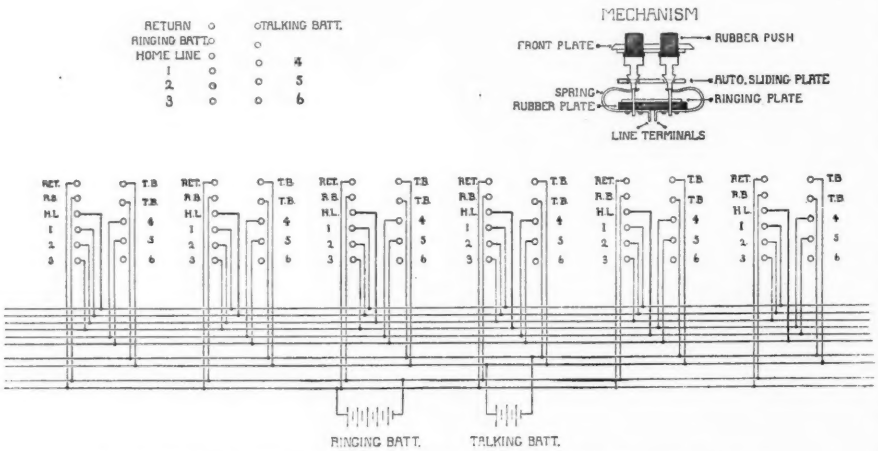


FIG. 2.—A SIX-LINE AUTOMATIC SWITCHLESS TELEPHONE WIRING DIAGRAM.

The automatic switchless telephone has made it possible for more than one or two pairs of telephones to be used at any one time without interference. Any one telephone can call and talk to more than one station at the same time. Any one telephone may have a single station telephone as an extension, and any telephone can secure secret conversation with a determined station by using the automatic secret button. In addition to this, one or two of the telephones may have an automatic trunk or exchange connection for long-distance service. This exchange connection can be used on both wall and desk telephones, and can be connected with magneto or common battery exchange systems.

An illustration is given herewith of the line connection for a six-station automatic switchless telephone system, the talking and ringing battery being placed at some central point. (See Fig. 2.)

For a six-station system there are required ten wires, using a separate bank of batteries for ringing and talking. Retardation coils are used on this system to prevent cross-talk. The diagram shown herewith may be used for a system up to fifty stations by employing four more wires in each case than there are telephones, as shown in the wiring diagram. The length of cable on this automatic system should not extend over 1,500 feet. Where there is a longer run of cable a magneto call should be used.

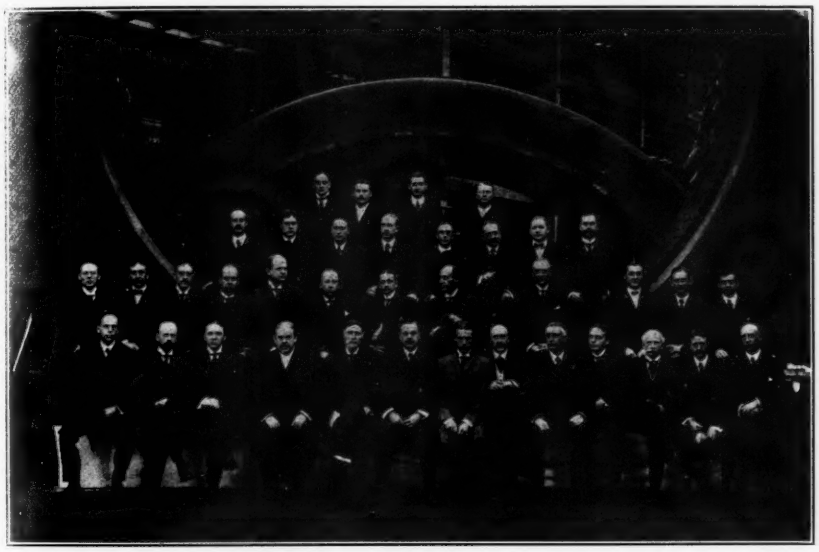
Cemetery Trolley Line Opened.

An electric railway has been opened for the accommodation of lot owners in the Loudon Park cemetery, Baltimore, Md., the opening event being the occasion of a luncheon given to the members of the Maryland Funeral Directors' Association at the Linden Mansion. The railway is the first of a series of developments which will be undertaken to improve the property. The road was built by Newell & Company, of sixty-pound T-rails, with stone ballast, and is one mile long. Two cars—the Loudon, with cane chairs, and the Linden, with side seats—will run at present. Each will seat twenty persons and accommodate a number of others standing. The current is furnished by the United Railways and Electric Company, of Baltimore. There is a siding at the receiving vault for the funeral car of the United Railways and Electric Company, and in the near future an entrance will be made from the Frederick road tracks west of the main entrance for the funeral car. Cars will be run on a regular schedule, and will be free to the lot holders. The line will later be extended to the new extension of the cemetery.

Westinghouse District Managers' Meeting.

The annual convention of the district managers of the Westinghouse Electric and Manufacturing Company was held November 13-16, at the general offices of the company at East Pittsburg. R. L. Warner, New England manager of the company, acted as chairman of the meetings, which were attended by the following representatives of the company:

C. S. Powell, general agent; W. F. Zimmerman, representative; Maurice Coster, manager export department; W. C. Webster, assistant to second vice-president; F. H. Shepard, New York; G. Pantaleoni, southwestern manager, St. Louis, Mo.; J. R. Gordon, manager, Atlanta; H. H. Seabrook, manager, Baltimore; D. E. Manson, manager, Boston; C. W. Underwood, manager, Buffalo; T. P. Gaylord, manager, Chicago; C. W. Regester, manager, Cincinnati; G. B. Dusinberre, manager, Cleveland; J. F. Johnson, manager, Dallas; L. M. Cargo, manager, Denver; C. F. Medbury, manager, Detroit; T. J. McGill, manager, Minneapolis; C. A. Bragg, manager, Philadelphia; W. F. Fowler, manager, Pittsburg; D. E. Webster, manager, St. Louis; W. W. Briggs, manager, San Francisco; M. P. Randolph, manager, Seattle; Paul T. Brady, manager, Syracuse.



Annual Convention of the District Managers of the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa., November 13-16, 1905.

At the opening session, which was held Monday morning, November 13, addresses were delivered by E. M. Herr, first vice-president of the company, by Frank H. Taylor, second vice-president, and by other officials.

At no time in the history of the company have the managers spoken with more enthusiasm of the business conditions in their respective territories. Among these opinions expressed were the following:

I have it from the lips of a representative of one of the largest commercial interests in South America, that the people in those countries would rather buy American machinery than buy European goods.

This statement was made by the manager of the export department. Speaking further on the prospects for export business, Mr. Coster said:

The outlook for foreign trade has never been brighter in this country than at present. The superiority of American machinery as compared with European manufacture is being demonstrated every day, and in those markets where the Germans and English have heretofore enjoyed a monopoly, America is now gradually obtaining the lion's share of the business. As far as the Westinghouse companies are concerned, we are enjoying the particular advantage that the name of Westinghouse is well known the world over; that our goods are used in every country on the globe, and hence we have no difficulty to obtain business for our companies.

R. L. Warner, New England agent, said:

The business outlook in New England was never brighter than at the present time, and especially does this refer to the Westinghouse Electric and Manufacturing Company. Our product is constantly growing in favor, and I also believe that the fact of the New York, New Haven & Hartford Railroad Company being about to operate its trains by the single-phase locomotive, will be a great factor upon the electric railway business of the Westinghouse companies.

F. H. Taylor, second vice-president, said:

I feel that this is a subject of congratulation, not only to ourselves, but also to the entire business interests of Pittsburg. That the prospects for prosperity in our works never will be brighter than at present. While we are already in possession of the facts which prove that the year 1905 has been the banner business year in the history of the factory, we have every reason to believe from the assurances given us by our district managers from all over the country, who have now been in session here, that the industrial advancement throughout this country promises an unprecedented activity.

Mr. C. S. Powell, general agent, New York city, said:

The adoption of electricity by the Pennsylvania Railroad on its lines, eastern division; by the New York Central on part of its lines; and the decision of the New York, New Haven & Hartford Railroad Company to operate trains with the single-phase locomotive will prove a great impetus toward increasing the future business in the electrification of railroad lines throughout the country.

T. J. McGill, the northwestern agent, located at Minneapolis, said:

Every indication at present in the Northwest leads me to believe that 1906 is going to be the greatest year in history.

J. R. Gordon, with headquarters at Atlanta, said:

The development of the South within the last five years has been truly phenomenal. Business, commercial and manufacturing enterprises are daily increasing. Electricity has had as much to do with this development as any other factor.

L. M. Cargo, representative for the district comprising Colorado, New Mexico, Wyoming, Utah, and Idaho, said:

The new discoveries of valuable minerals are made in our district almost every hour, and the wealth of gold, silver and copper, especially the latter, is inestimable. This means a greater development of the mining industry of that country than has yet been dreamed of, and, inasmuch as the application of electricity makes the operation of mines an easy task, we are looking for a great business in that branch of the industry.

W. W. Briggs, of San Francisco, said:

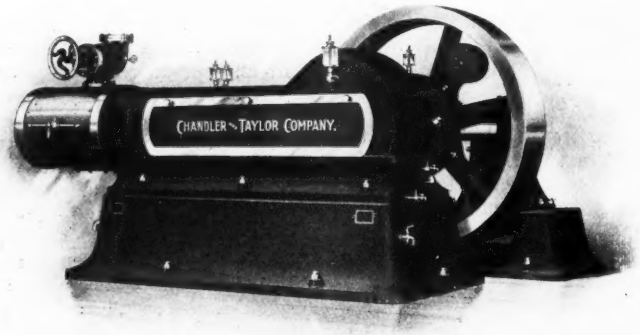
The people on the Pacific slope are looking forward to a period of uninterrupted prosperity. I believe that the development of interurban railway business has only just commenced and with the perfection of the single-phase locomotive and the steam turbine, this particular branch of the business will be very much greater than it has been heretofore.

C. A. Bragg, district manager, of Philadelphia, said:

In regard to the prospects for business in the coming year, they appear to me most flattering. If we have had successes in the past and banner years, I think the coming one will make them look insignificant as regards the amount of profitable business there is ahead of us.

Enclosed, Self-Oiling, Direct-Connected Engines.

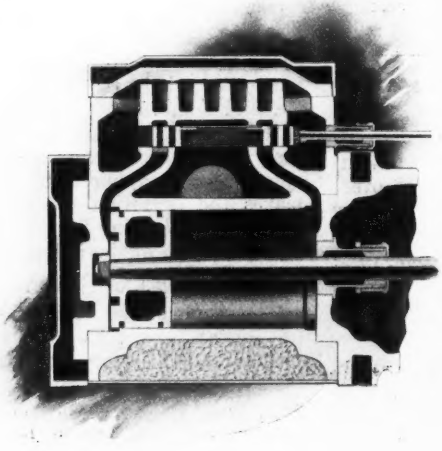
The Chandler & Taylor Company, Indianapolis, Ind., is building a line of direct-connected engines of the enclosed type, which is meeting with general success in all parts of the country. There



FRONT VIEW, ENCLOSED, SELF-OILING, DIRECT-CONNECTED ENGINES.

are many little bits of mechanical ingenuity incorporated in the design, making this engine peculiarly adapted for direct-connected service.

The machines are designed, the company states, exactly in accordance with the specifications of the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The engine is of the side-crank pattern, and particular attention is given to many of the structural details. The main crank-

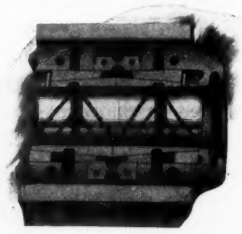


CYLINDER, ENCLOSED, SELF-OILING, DIRECT-CONNECTED ENGINE.

bearing, illustrated herewith, might seem, at first glance, to be too complicated for ordinary service. In detail, however, the assembly is decidedly simple and worked out so as to give a maximum of service with a minimum amount of attention. The main crank bearing is self-centering, and can be adjusted while the engine is in operation. It is self-oiling, and can have its lining shells removed without dismantling any part of the engine or generator field frame. The self-centering feature makes it peculiarly adapted to direct-connected service, because as wear occurs it can be taken up, keeping the centre of the shaft in the line upon which the engine was originally assembled.

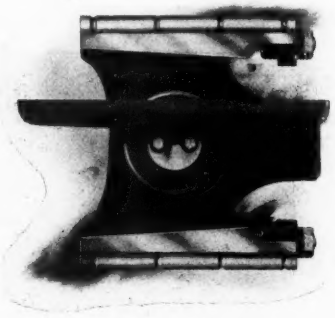
The outboard bearing used with this line of machines is what is commonly known as a dynamo type, and consists of a split box mounted on three heavy cap-screws, these screws being supported by the outer pedestal. This arrangement permits of an adjustment in any plane, even though there should be an excess settling of the foundation under this part of the machine. This bearing is also self-oiling.

The cross-head is of the well-known box form, the body being a casting of steel, and the adjustment for wear in the guides being made by tapered shoes. These shoes are made solid, and of a bronze suited to a bearing surface of this character. The wear in the guides is adjusted by the wedge-shaped shoes, the shoes being locked firmly to the cross-head by studs and nuts



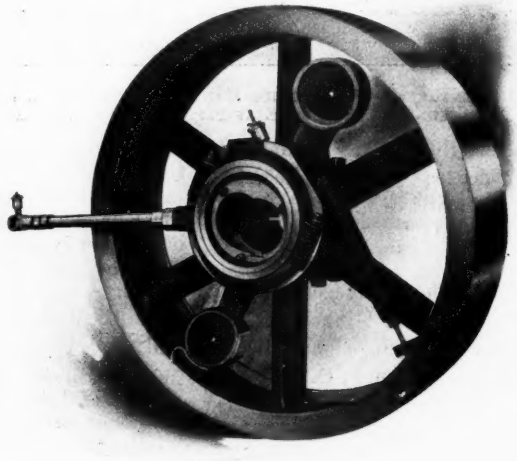
CRANK-SHAFT BEARING.

on the inside of the cross-head body. This design prevents any pounding between the cross-head shoe and the cross-head proper.



CROSS-HEAD.

The valve is of the well-known double-ported, grid-iron type. This construction eliminates friction and gives a small clearance space, with ample port openings.



FLYWHEEL AND GOVERNOR, ENCLOSED, SELF-OILING, DIRECT-CONNECTED ENGINE.

The valve is arranged to automatically lift off the valve seat, and automatically replace itself, if a charge of water should come over into the cylinder.

The governor is of the well-known Rites inertia type, so constructed that the centre of gravity of the inertia arm is always

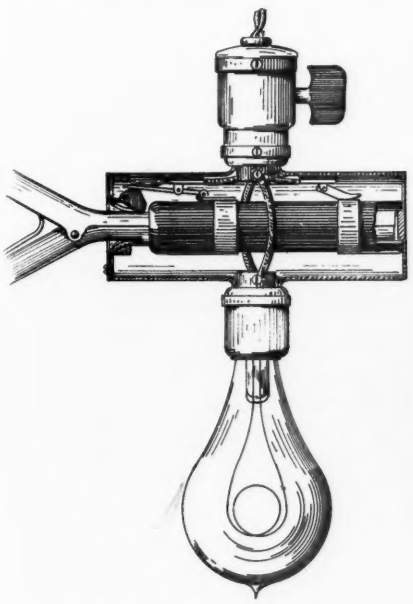
maintained in a line perpendicular to the line of the governor-supporting pin. This is accomplished by forming the water-pockets on both sides of the inertia arm, and prevents any cross-balance, eliminating a wobbly eccentric or an oddly shaped governor-pin.

Particular attention has been paid to the feature of enclosing the engine. Even the eccentric is entirely enclosed with a cast-iron guard, and between the sides of the strap there is placed an oil deflector, which keeps the oil from being drawn into the governor-wheel. A felt packing plate is placed on the eccentric rod just forward of the opening in the eccentric oil-guard, so that any oil which might be thrown out of this opening is deflected back to the oil chamber.

During a recent test it was determined that with a 100-kilowatt machine operating continuously from Sunday morning of one week to Sunday morning of the next week, the weekly oil bill, including both engine and cylinder oil, was a trifle less than seventy-five cents. This, reduced to an ordinary run of ten hours a day, with 300 working days in a year, would make the yearly oil bill $13.20.

Electrical Curling-Iron Heater.

The accompanying illustration shows the new form of electric curling-iron heater invented by Frederick A. Tobler, 743 Howard street, San Francisco, Cal.



ELECTRICAL CURLING-IRON HEATER.

The device represents an electrical curling-iron heater especially adapted for the use of travelers. It is designed to take the place of an ordinary incandescent lamp in the regular socket. The incandescent lamp burns independently of the heating element. The heating element is cut in and out of circuit by the insertion and extraction of the curling-iron.

A practical feature of this apparatus is that the heating element, when burned out, can be easily taken out and replaced. No special tools are required to make the change, and there are no terminals to detach. When the new heating element is inserted, the contact shoes operate automatically. The heater weighs, complete, four ounces.

Some Convenient Telephone Instruments.

The accompanying illustrations show some of the convenient telephone apparatus which is being made by the Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. Fig. 1 is an intercommunicating portable desk telephone, designated as style "I. B." This style of telephone has been on the market for a number of years, and some of the largest telephone exchanges have thousands of them in daily use. The instrument is neat, substantial and fully nickel-plated. It is a desirable and practicable instrument for the office superintendent of a factory, and for similar places.

FIG. 1.—PORTABLE INTERCOMMUNICATING DESK TELEPHONE.

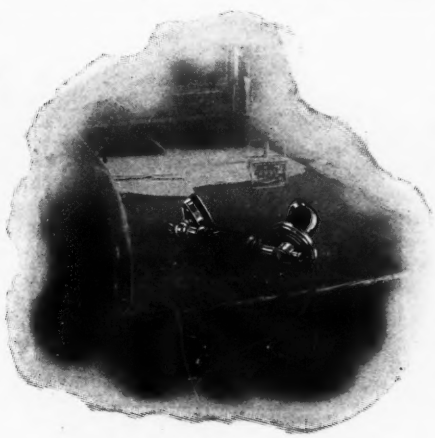


FIG. 2.—COMBINATION TELEPHONE.

Fig. 2 is a convenient type of instrument for the use of bankers and business men. It is known as style "H C," and is a combination telephone, the receiver and transmitter being attached together by means of a neat handle. By simply placing the receiver to the ear the signal is given to the operator. The instrument is provided with flexible green silk-covered cord of good length, and is elegantly made throughout.

The "H B" type is an instrument designed to meet the needs of the office manager. The receiving and transmitting instrument is similar to that shown in Fig. 2, except that when it is not in use it is hung on the hook, and not laid upon the desk. This instrument gives the user a great amount of freedom. It may be mounted on the side of a desk or inside a roll-top desk, if desired. Each instrument is handsomely finished and provided with green silk-covered cord of good length.

A New Condenser.

A new type of condenser has been brought out by the French Westinghouse Company and M. Le Blanc, which has some interesting features. The following description is taken from the *Mechanical Engineer* (London):

The condensing water is supplied through a pipe into a condensing chamber. This chamber is large, so that as the steam flows through it, its velocity will be small. The condensing chamber, however, contracts at its lower end to a comparatively small opening, at the mouth of which is placed a centrifugal pump, or turbine driven in the reverse direction, which catches the water of condensation as it issues from the chamber, and forces it through a series of nozzles of the injector type. By this arrangement the water is quickly removed from the condensing chamber—so quickly that it has not time to give up its contained air, and a high vacuum is maintained.

University of Illinois Test Car.

The electrical equipment for the test car of the electrical engineering department of the University of Illinois is now being installed at the shops of the Illinois Traction System. The car will be ready to run in about a week, and through the courtesy of the Illinois Traction System will be used over its lines in making tests of the amount of power required for different speeds and grades, under varying loads. The car is of the interurban type. It is equipped with Westinghouse apparatus, and was built by the Jewett Car Company.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

DIRECT CABLE TO SHANGHAI—A cable has been completed by the German Dutch Company between Guam, Yap and Shanghai, China, connecting at Guam with the Commercial Pacific Cable system. The new cable obviates the route via Manila for messages from this country to Chinese points, and affords direct connection with Shanghai.

NEW TELEPHONE COMPANY'S CAPITAL NOW $5,000,000—The new Home Telephone Company, of Detroit, Mich., was reorganized on Monday, November 6, and the nominal capital stock of $10,000 named in the first articles of incorporation was increased to $5,000,000. A controlling interest has been purchased in the Peninsula Telephone Company, the toll line company organized in connection with the Cooperative Telephone Company, and capitalized at $100,000.

SHOSHONE FALLS WATER POWER—The Shoshone Falls Power Company, controlling the water rights on the Snake river, at Shoshone falls, Twin falls and Auger falls, Idaho, with a capital of $4,000,000, has announced that within fourteen months it will supply electric power to Salt Lake City, Utah, through a transmission system 170 miles in length. It is stated that the hydraulic equipment, with a capacity of 25,000 horse-power, is practically completed.

TO BUILD ELECTRIC LINE UP MONT BLANC—A large number of workmen have been brought to Geneva, Switzerland, to begin the construction of the new electric line which is to take tourists nearly to the top of Mont Blanc. The length of the line will be about twelve miles, and the electric system is the same as the one in use on the Jungfrau. The new line will start from the village of Lafayet in Chamonix, and gradually ascend to the northwest side of the mountain up to the plateau.

TO CHICAGO BY TROLLEY—A new electric railway system, planned by Pittsburg capitalists, is projected to run from Newcastle, Pa., down the Sewickley valley to Beaver, where it will connect with the Beaver valley traction system of the Pittsburg Railway Company. Through the connections of the latter system it will go to Pittsburg. The company is to be chartered this month, and among those interested are T. G. Hamilton, of Fitzgerald & Hamilton, Pittsburg; Stanley Vickers, C. G. Gerber, Harry Ethridge, E. M. Bassinger, and others. It is said that the road will be about thirty miles long, and will be built according to the latest ideas.

TWO SYSTEMS ADDED TO THE BELL TELEPHONE EXCHANGES IN PENNSYLVANIA—Two telephone franchises have been secured by the Bell Telephone system in Pennsylvania. Contracts have been closed by the Central District and Printing Telegraph Company for the Farmers' exchange at Lowell, Ohio, and for the franchise of the Murraysville Telephone Company at Export, Pa. The Lowell company is located in five townships of Washington County, Ohio, and has 180 subscribers. The Murraysville Telephone Company is located in Westmoreland County, and the line is now being built. The company has 140 subscribers, most of whom are farmers. The central exchange will be located at Export, and will have a direct connection with Pittsburg. With the addition of these two concerns, the Bell company now has more than 20,000 stations.

NEW POWER PLANT IN OREGON—The North Santiam river, one of the most powerful streams in Oregon, is to be the scene of a power plant to operate the proposed electric line from Portland up the Willamette valley to Eugene or Roseburg. Rights have been secured on the river from Detroit, the eastern terminus of the Corvallis & Eastern Railroad, down to Mehama, where the river leaves the mountains, a distance of about twenty-eight miles. The North Santiam is about seventy miles long, full of waterfalls, narrows and rapids, and is continued from the snowbanks of Mount Jefferson, down the cascades and across the valley into the Willamette. After leaving the mountains it flows across the northern part of Linn County, and a few miles above its mouth joins the South Santiam river, which flows northwest from the vicinity of the Three Sisters. The united stream enters the Willamette about ten miles from Albany.

CALIFORNIA ENTERPRISE TO WORK A NEW WATER POWER—A corporation is being formed for the purpose of erecting a large power plant within ninety miles of Los Angeles. Mr. A. K. Detwiler, a resident of California, is the principal party in the corporation. It is stated that besides entering the field as a producer of electricity, the company will build dams and lay pipes for the distribution of 7,500 inches of water to certain points. Mojave river valley will be the chief scene of the new corporation's operations. The company has secured riparian rights to cover a watershed in the San Bernardino range. In order to develop the water power, a dam is to be constructed at Victor narrows, which forms a large natural reservoir. At this point there will be constructed a plant which will develop 15,000 horse-power. The estimated cost is expected to be in the neighborhood of $800,000, and the plant will be completed within two years.

NEW PUBLICATIONS.

TWELFTH ANNUAL CONFERENCE OF THE RAILROAD DEPARTMENT OF YOUNG MEN'S CHRISTIAN ASSOCIATION—The proceedings of the twelfth international conference of the railroad department of Young Men's Christian Associations of North America, held at Detroit, Mich., from September 28 to October 1, 1905, have been published. In addition to the day-by-day report of the sessions there is a register of the members of the conference and a series of excellent illustrations of the prominent members of the various organizations. The frontispiece is a reproduction of the large group photograph taken on the occasion of the convention at Detroit. The publisher is the international committee of Young Men's Christian Associations, New York city.

REPORT OF THE BOARD OF RAPID TRANSIT COMMISSIONERS OF THE CITY OF NEW YORK—The report of the Board of Rapid Transit Railway Commissioners of the city of New York for the year 1904 has been issued. This gives an account of the work accomplished during that year. The volume contains also the report of the chief engineer, Mr. William Barclay Parsons, upon the work done, and the report of the auditor, together with seven appendices. The first of these gives a list of the commissioners and the staff; the second is an account of the proceedings of the opening of the rapid transit railway; the others deal with court opinions upon certain phases of the work, proposed new routes, reports upon rolling stock and safety appliances, and certificates to the New York Connecting Railroad, and the New York & New Jersey Railroad Company.

THE MANUFACTURERS OF THE UNITED STATES STANDARD REFERENCE BOOK—The fifth edition of the Manufacturers of the United States Standard Reference Book is a bulky volume weighing twelve and one-half pounds, and containing over 3,000 pages. The book is made up of a complete list of the names and addresses of manufacturers throughout the United States. The manufacturers are classified alphabetically, and an index of 241 pages renders it particularly easy to secure the name and address of a manufacturer of any material. The book enumerates and classifies 512,734 manufacturers, covering an output of 52,596 articles of every known variety. This work was originally started in 1882, in the form of a small pamphlet of forty-six pages, weighing three ounces. The demand for this book of reference has kept pace with its growth, and it is now a prominent part of the reference library of mercantile establishments in every part of the world where American manufactures are known. The book is substantially bound in heavy boards covered with red cloth, and measures nine by twelve and one-half inches. It is published by the Manufacturers' Red Book Publishing Company, 225 Fourth avenue, New York city.

PERSONAL MENTION.

MR. VICTOR C. GILPIN announces that he is now representing, at 120 Liberty street, New York city, the Tower-Binford Company, knife switches and panelboards; the Monarch Electric Manufacturing Company, "Monarch Special" lamps, "Monarch" arc-burst, and the Acme Lamp Company, refilled lamps.

MR. GEORGE W. JOHNSON, Jackson, Mich., has been appointed manager of the Michigan State Telephone Company's office at that place to succeed Mr. D. D. Shane. Mr. Shane becomes district manager, his jurisdiction extending to Delta, Wacousta, Potterville, Mulliken and the territory included by the foregoing towns.

SIGNOR GUALTIEROTTI, minister of the Italian posts and telegraphs, has appointed a commission, under the presidency of Signor Blaserno, to study the development of wireless telegraphy, with a view to the establishment of ten wireless stations in the principal commercial points of Italy, to be used for public service.

MR. J. STANLEY RICHMOND, the well-known specialist upon railroad track construction and electrical engineering, dealing particularly with the elimination of electrolytic troubles, has for some time been traveling troughout the country. Mr. Richmond now announces that he is connected with the hydroelectric power commission of the Province of Ontario.

MR. GEORGE S. HASTINGS is in charge of the new Cleveland (Ohio) office, 416 Electric Building, of the National Electric Company, Milwaukee, Wis. Mr. Hastings will handle the complete line of the company throughout Ohio, Indiana, Michigan, West Virginia and New York as far east as Schenectady, and electrical machinery only in Pennsylvania as far east as Johnstown.

MR. RALPH D. MERSHON has been retained by the African Concessions' Syndicate, Limited, of London, in connection with the proposed development of power at Victoria Falls on the Zambesi river, Rhodesia, South Africa, and its transmission to Johannesburg and the Witwatersrand, for use in connection with gold mining. The distance of transmission will be about 700 miles. Mr. Mershon has just returned from a flying trip to Europe, made for the purpose of consultation relative to this enterprise.

MR. H. T. EDGAR, vice-president and manager of the El Paso Electric Railway Company, has resigned to accept the vice-presidency of the Northern Texas Traction Company, which consists of the electric railway system in the city of Fort Worth, Tex., and the interurban line from Fort Worth to Dallas. He will manage this property with headquarters at Fort Worth, leaving El Paso about December 1. Mr. Edgar has been the manager of the El Paso Electric Railway Company since its organization, and superintended its construction and installation.

OBITUARY NOTICES.

MR. FREDERICK H. BETTS died at his home, 22 East Sixty-fifth street, New York city, on Friday, November 10. He was an authority on patent law, and was counsel in some famous patent cases for the Western Union Telegraph Company, the American Bell Telephone Company, the Edison Electric Light Company, the General Electric Company, the Westinghouse Electric and Manufacturing Company and the Westinghouse Air-Brake Company, and the Marconi wireless systems in England and the United States. He was also patent counsel to the city of New York. In 1872, and for several years thereafter, he was counsel for the state insurance department. He was born in Newburgh, N. Y., in 1843.

MR. H. S. HENDERSON, of Rome, N. Y., an old-time railroad and telegraph man, died at the Rome Hospital on the morning of November 13. Mr. Henderson was born at Rome, N. Y., January 9, 1835. He was educated at the public schools and the Rome Free Academy, and at the age of sixteen learned telegraphy and went to Kingston, N. Y., in charge of a commercial office. After considerable experience he went to Lockport as manager of the Western Union office. He was division operator of the Delaware system of the railroad at Port Jervis. He was transferred from that point to Jersey City, N. J., and filled the same position on the eastern division and branches, where he remained thirteen years, a large portion of the time as chief train despatcher. From Jersey City he went to Norwich as chief train despatcher of the northern division and branches, and in charge of the telegraph. He went to Rochester, N. Y., in May, 1878, four days before the first train was run through to Salamanca, as chief train despatcher and superintendent of telegraph of the Rochester & Pittsburg Railroad. When this road was merged into the Buffalo, Rochester & Pittsburg Railroad he was retained as train-master and superintendent of telegraph, remaining in this company's service nearly twenty-five years, the latter part of which he was a traveling agent in the transportation department.

ELECTRICAL SECURITIES.

Speculation last week was almost wholly dominated by monetary considerations. Notwithstanding the wide fluctuations in prices and the feverish activity in many lines, the significant fact remains that the market has shown a remarkable resistance to adverse conditions. It is expected now that the period for dividend disbursements and profit-taking is close at hand, that new investment features will be developed and that the bank surplus can be so built up as to relieve, in the very near future, any money stringency which may be apprehended at the present time. The coming winter season, without definite announcement of inimical relations between labor and capital, and the continued good reports from every industrial quarter, indicate that a season of prosperity is at hand, and that good things will continue to be the order of the day.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 18.

New York:	*Closing.*
Brooklyn Rapid Transit	81¾
Consolidated Gas	179
General Electric	185⅛
Interborough Rapid Transit	211½
Kings County Electric	200
Manhattan Elevated	163½
Metropolitan Street Railway	116
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	192

The regular quarterly dividend of 2 per cent has been declared on the stock of the Kings County Electric Light and Power Company, payable December 1.

The entire Interborough Rapid Transit system (including the subway and Manhattan divisions) reports as follows for the quarter ended September 30, 1905: gross, $3,905,097; expenses, $1,967,447; net, $1,937,650; other income, $159,841, a total of $2,097,491; charges, $1,987,672, leaving a surplus of $109,819. For the nine months ending September 30 the surplus is $1,540,859. At the annual meeting of the company only routine business was transacted.

The New York City Railway Company reports as follows for the quarter ended September 30, 1905: gross, $4,509,610; expenses, $2,292,258; net, $2,217,352; other income, $339,416; total income, $2,556,768; charges, $2,803,050, leaving a deficit of $246,282, as compared with a surplus of $179,475 for the same quarter of 1904. At the annual meeting of the New York City Railway Company the retiring directors were reelected.

Boston:	*Closing.*
American Telephone and Telegraph	136
Edison Electric Illuminating	246
Massachusetts Electric	55
New England Telephone	135
Western Telephone and Telegraph preferred	90¼

Philadelphia:	*Closing.*
Electric Company of America	11½
Electric Storage Battery common	81
Electric Storage Battery preferred	81
Philadelphia Electric	8⅝
Philadelphia Rapid Transit	31⅞
United Gas Improvement	93⅝

The directors of the Philadelphia Electric Company have declared the regular semi-annual dividend of 2½ per cent, payable December 15.

Chicago:	*Closing.*
Chicago Telephone	137
Chicago Edison Light	160
Metropolitan Elevated preferred	70½
National Carbon common	63
National Carbon preferred	116
Union Traction common	11½
Union Traction preferred	37

It is stated that the fall business of the Union Traction Company shows a very fair gain over that of a year ago.

ELECTRIC LIGHTING.

JORDAN, N. Y.—The power plant of the Jordan Lighting Company has been completed.

OTTAWA, ONTARIO—The Stanstead Electric Light Company has extended its lines to Derby Centre.

PIERRE, ILL.—A stock company of Miller citizens has bought the town electric light plant and will improve it.

FLORENCE, S. C.—The Florence Light and Power Company has placed an order for almost an entire new electric light plant.

AVALON, N. J.—The borough council has employed an expert to formulate plans and estimates for the installation of an electric lighting plant.

SPOKANE, WASH.—The Washington Water Power Company has accepted plans for a four-story and basement building for station and office purposes.

VALLEJO, CAL.—Calistoga is to have an electric light plant, which will be installed by the Calistoga Electric Light and Power Company, capitalized at $20,000.

HOUGHTON, MICH.—The village council of L'Anse has awarded the contract for the municipal lighting plant to the Superior Construction Company, of Houghton.

WILMINGTON, N. C.—Fayetteville has awarded the contract for overhauling and enlarging its electric light plant to the Allis-Chalmers Company, of Milwaukee, Wis.

SUMPTER, ORE.—Actual construction work on the plant that is to generate 1,200 to 2,000 horse-power by the utilization of the waters of Olive lake is now in progress.

WEST MEDWAY, MASS.—The selectmen have signed a contract for 125 lamps of twenty-five candle-power, at $13.50 per year, moonlight schedule. The agreement takes effect before January 1.

RUTHERFORD, N. J.—A contract for street lighting for three years, at $16 a lamp per year, has been awarded to the Public Service Corporation by the East Rutherford borough council.

MESSENA, N. Y.—The plant and franchises of the Brushton Electric Light Company have been sold at auction for $900 to A. L. Donaldson, representing the Brushton stockholders of the company.

CLARKSBURG, W. VA.—The Clarksburg Gas Company and the Clarksburg Electric Light Company have consolidated. The new company is known as the Clarksburg Gas and Electric Light Company.

FLORA, ILL.—The electric light committee, representing the Flora city council, has rejected the proposition of the General Utilities Company which sought to purchase the municipal lighting plant.

ROCHESTER, N. Y.—The Lockport, Niagara & Ontario Power Company has secured all the necessary rights of way to pass through the town of Sweden, and work of erecting the towers to carry the cables will soon be begun.

ANSONIA, CT.—The principal streets of Beacon Falls are to be lighted by electricity. There will be twenty-five incandescent lamps installed in the near future. The lamps will be of fifty candle-power, and will cost the town $50 a year per light.

OWINGSVILLE, KY.—According to reports a syndicate of eastern capitalists is preparing to install a large electric light plant at Rockcastle Falls, in the Rockcastle County mountains, to furnish light and power for that entire section of the state.

GAYLORD, MICH.—A company is being organized for the purpose of utilizing the current in the Manistee river, near the village of Sherman, Wexford County. The power obtained is to be distributed to the nearby towns for commercial purposes.

CORNWALL, N. Y.—The Cornwall town board has signed a contract with the Hudson Counties Gas and Electric Company on an all-night schedule of $20 per light for the year. This is an increase of a little less than $2 over the former contract for moonlight schedule.

EUGENE, ORE.—The option on the Lane County Electric Company's property held for some time by I. W. Anderson, of Spokane, and A. Welch, of Salem, has been closed and the property has passed into the hands of the firm of Rhoades, Sinkler & Butcher, of Philadelphia.

SAN FRANCISCO, CAL.—The board of supervisors has approved the recommendation of the board of public works and the inspector of light and water for the establishment of 103 new street arc lights to be located at various points throughout the city, chiefly in the western and southwestern suburbs.

SUNAPEE, N. H.—The Sunapee Electric Light and Power Company, now owned by the Newport Electric Light Company, has just completed the work of rebuilding its system. This work was commenced last April, and since that time the company has set about 275 poles and strung twenty miles of new wire.

LONDON, ONTARIO—A company has been formed, with ample capital, for the purpose of generating power in the neighborhood of London, and the purchase of the necessary land is in progress. The site of the prospective power plant is on the Thames, below Kilworth, eight miles from the city. The river has a heavy fall at this point.

WINONA, MINN.—The Minnesota Light and Power Company, which this year developed a water power of 200 horse-power at Minnesota City, has recently had the ground looked at by an engineering authority, and is prepared to award contracts for increasing the capacity to 800 horse-power with 1,000 horse-power for eight hours in the day.

UTICA, N. Y.—The Utica Gas and Electric Company has entered into a contract with the Rome Gas Company, whereby the former concern is to furnish electricity for lighting the city of Rome. A high-tension line will be built and power will be furnished from Trenton Falls to Rome, where it will be transformed to the proper voltage for the different requirements in that city.

CANNON FALLS, MINN.—A deal has been completed by which the Cannon River Electric Power Company has become the owner of the Northfield Light, Heat and Power Company. The plant of Northfield will be managed by its present owners for a year, when it will pass into possession of the purchasers. Power for the plant at Northfield and also the local plant will eventually be transmitted from the dam to be built across the Cannon river, one mile west of the falls.

HARTFORD, CT.—The stockholders of the Hartford Electric Light Company held a meeting recently and voted to increase the capital stock from $1,600,000 to $1,800,000. The charter amendments granted by the last legislature were also accepted. These, in brief, give the company privilege to increase its capital stock to $3,000,000, and also to carry on business in Rocky Hill. Immediately after the stockholders had adjourned the directors met. They voted to issue 2,000 new shares of stock at par.

SHELBYVILLE, IND.—Edward Daniel, master in chancery of the Indiana District of the United States Circuit Court, transferred the Shelbyville water and light plant, at Shelbyville, to Charles F. Street, and Mr. Street then transferred the property to the Citizens' Water and Light Company, of Shelbyville, under which name the company will now be known. A mortgage for $50,000 on the plant and property has been given to the United States Mortgage and Trust Company, and filed with the recorder of Shelby County.

LOS ANGELES, CAL.—Papers have been signed by representatives of a local syndicate completing the purchase of the gas plants at Redlands and Colton, which will hereafter be operated by the Edison Gas and Electric Company. The Edison company in connection with the local syndicate already has control of the plants at Riverside, Ontario, Pomona and Whittier, and the purchase of the two above mentioned plants completes a chain through the whole San Bernardino valley. The price paid is approximately $250,000, and improvements to the present system will be made as soon as plans can be prepared.

EDUCATIONAL.

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY—The Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., will hold the founder's day exercises on Thursday evening, November 30, at eight o'clock. The address of the evening will be delivered by Mr. John Cassan Wait, of New York city. Mr. Wait is the pioneer in a specialty in the practice of law—that of engineering and architectural jurisprudence. In this branch he is an acknowledged authority, and is the author of several books on the subject.

ELECTRIC RAILWAYS.

OWOSSO, MICH.—The contract for the construction of the Grand Rapids & Ionia, Grand Rapids, Belding & Greenville, Ionia & Owosso, and Owosso & Pontiac electric railways has been signed.

PEORIA, ILL.—The McKinley Interurban Company has been granted a twenty-year franchise by the city of Peoria. The ordinance passed recently provides for the payment of $15,500 by the McKinley syndicate to the city of Peoria in yearly instalments for twenty years or the term of its present franchise.

SHELBYVILLE, IND.—Another new interurban road is proposed which, if constructed, will connect Columbus with Shelbyville by way of Hope. The capital will be furnished by Hope and Columbus men, and the company will be organized soon. Work on the extension of the Indianapolis & Cincinnati from Shelbyville to Greensburg is progressing rapidly.

ROCHESTER, N. Y.—It is said that the Rochester, Scottsville & Caledonia Electric Railroad Company is considering a proposition to extend its road south to Perry and Nunda. If it does so it will lay tracks on the route graded by a company organized in 1840 as the Rochester & Nunda Railway Company, which graded almost from Greigsville to Nunda by way of Moscow.

BROOKLYN, N. Y.—The Brooklyn Heights Railway Company has recently placed an order with the Westinghouse Electric and Manufacturing Company for a substantial addition to its present equipment, consisting of 300 No. 101-B Westinghouse direct-current railway motors and 150 sets of controllers. The order for motors is in addition to one placed some months ago for 600 motors of the same type.

NIAGARA FALLS, N. Y.—The formal transfer of the majority stock of the Electric City Railway Company, by which the control of the company passed into the hands of the International Railway Company, took place at a meeting held in the office of President Michael of the River City Construction Company in Buffalo. Following the transfer of stock officers were elected as follows: president, H. J. Pierce, Buffalo; secretary and treasurer, Fred Slocum, Buffalo.

WATERBURY, CT.—Plans are under way for a trolley line from Woodbury to Danbury. It is proposed to build a line from the terminal of the Waterbury-Woodbury road, running the same through the village of Sandy Hook, Newtown into Bethel, connecting with the present Danbury line. When this proposed line is completed and a few other connections and extensions made, it is expected that this will be the quickest and most direct route from Waterbury to New York.

FORT WAYNE, IND.—It is now probable that there will be two electric interurban roads built from Fort Wayne north to Auburn and Garrett, one being the extension of the Toledo & Chicago interurban, promoted by the Seagraveses, and the other the extension of the Fort Wayne & Wabash Valley Company, which has a line in operation from Fort Wayne to Logansport, and also a line to Lima. The roads from Fort Wayne north will practically parallel each other, passing through many of the same towns.

NEWARK, N. Y.—Work has been begun in Newark for equipping with electricity the West Shore Railroad from Rochester to Syracuse. The contract has been let by the Ontario Electric Power Company, of Niagara Falls, to the Buffalo Pole, Line and Construction Company, which is to erect a series of derricks between the two cities mentioned on which are to be hung three aluminum cables for the transmission of power. The work involves an expenditure of $550,000, and according to contract must be finished by March 1, 1906.

BLOOMINGTON, ILL.—The interurban mileage of Illinois will be largely increased in 1906 and in 1907. It is expected that trolley service will be established between Chicago and St. Louis. The Illinois Traction Company, of which W. B. McKinley, of Champaign, is the president, has already completed plans for laying 135 miles of track next year, and this amount may be exceeded if conditions continue favorable. In two years the trolley will be in service between Bloomington and Chicago, and with connections now under way, will permit a continuous ride between Chicago and St. Louis by electric line.

TELEPHONE AND TELEGRAPH.

OAKLAND, CAL.—The Oakland city council has granted a franchise to the Home Telephone Company.

PHILADELPHIA, PA.—An independent line is being built between Richland and Sheridan Berks County.

JACKSON, MISS.—The Home Telephone Company, of McComb, has been purchased by the Cumberland company.

DANIELSONVILLE, CT.—The Southern New England Telephone Company has opened a new exchange in Jewitt City.

FARGO, N. D.—The Northwestern Telephone Exchange Company is building a new line from Grafton to St. Thomas.

PHILADELPHIA, PA.—The Delaware & Atlantic Telephone Company is putting its wires underground through all the principal streets in Riverton.

WHITE HALL, ILL.—The Illinois Telephone Company has installed in the White Hall exchange office a switchboard with a capacity of 450 instruments.

PETERSBURG, VA.—The Petersburg Telephone Company has extended its lines to Stony Creek, where it will connect with the Sussex & Southside company.

ROCKVILLE CENTRE, N. Y.—A franchise has been granted the New York & Montauk Telephone Company to operate a system in the town of Rockville Centre.

WILLIAMSBURG, VA.—The Chesapeake Telephone and Telegraph Company, organized in 1900, has passed into the hands of the Southern Bell Telephone Company.

QUINCY, ILL.—The Quincy Automatic Telephone Company has increased its capital stock from $15,000 to $1,000,000 and changed its name to the Quincy Home Telephone Company.

BALDWINSVILLE, MASS.—At a meeting of the selectmen it was voted to grant a franchise to the Otter River Telephone Company to construct and maintain telephone lines and exchanges throughout the town of Templeton.

SHEBOYGAN, WIS.—The Citizens' Telephone Company, of Sheboygan, has sold the full line between Dacada and Fredonia by way of Random Lake to Silver Creek to W. B. Krause and M. Schmidler, of Port Washington, and Dr. Mallory, of Random Lake.

GERMAN VALLEY, N. J.—The Chester Telegraph Company has completed its line from German Valley to Middle Valley, Custmoor, Vernoy and Califon. At the latter place it connects with the Farmers and Merchants' Telephone Company's line, giving service to High Bridge, Clinton, Flemington, Frenchtown, Whitehouse, Milford and Bloomsbury.

TROY, N. Y.—At the annual meeting of the stockholders of the Clinton Telephone Company, the following were the directors elected: E. M. Woodward, C. A. Gardner, I. R. Coughtree, T. M. Brush, I. H. Griswold, L. W. Hayes, B. S. Ramsay, A. Sharron, J. M. Weaver and I. Merkel. At a subsequent meeting of the directors the following officers were chosen: president, I. H. Griswold; vice-president, B. S. Ramsay; secretary, I. R. Coughtree; treasurer, I. Merkel; manager, E. L. Graul; assistant manager, C. L. Howk.

PARSONS, KAN.—A charter has been granted the Citizens' Home Telephone Company, a corporation with a capitalization of $500,000, organized for the purpose of taking over and consolidating all the independent telephone companies in southeastern Kansas. The incorporators are: James Plottner and George Yeager, of Kansas City; Fred Perkins and D. J. Romine, of Oswego; George Spangle, of Chetopa, and C. H. Kimball and F. H. Brown, of Parsons. The companies to be consolidated are: Pittsburg Home Telephone Company, Galena Home Telephone Company; exchanges at Galena, Weir City and Scammon; Labette County Telephone Company; exchanges at Oswego, Chetopa, Altamont, Mound Valley, Edna and Bartlett, and Parsons Home Telephone Company. The consolidated companies have a total of 3,000 telephones and over 400 miles of toll lines. A copper circuit will be put in from Pittsburg, connecting with the St. Louis and Kinloch long-distance lines by way of Parsons to Cherryvale, where it will connect with the Kansas City Home Telephone Company's long-distance lines.

INDUSTRIAL ITEMS.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., has recently closed a contract with the Arbuckle-Ryan Company, of Toledo, Ohio, for two 250-kilowatt, engine-type, alternating-current generators, for installation at Canton, Ohio.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has issued a series of handsome bulletins describing and illustrating sampling plants and equipment, portable rock-crushing plants, forged steel balls for ball mills and the Bennetts pouring spoon.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., in bulletin No. 61 describes and illustrates belt type direct-current machines. These machines are for general power purposes and small lighting plants. The details of construction are carefully explained, and the illustrations give a good idea of the design of this apparatus.

THE JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., has issued a handsome catalogue replete with illustrations and information upon cableways, suspension bridges and like installations, of which it makes a specialty. These installations cover all parts of the country, and the book is worthy of a permanent place in any engineering library.

THE ECONOMICAL ELECTRIC LAMP COMPANY, 227-229 Fulton street, New York city, reports a marked success among supply dealers from the use of the automatic electric sign or "window demonstrator," which it furnishes to contractors, central stations and electrical fixture dealers who order fifty or more lamps. This company manufactures the "Economical" turn-down lamp.

NEW TELEPHONE MANUFACTURING PLANT—It is announced that a large plant for the manufacture of independent telephone apparatus will be established at St. Louis, Mo., to cost nearly $6,000,000, and that the demand for independent apparatus in the West will be supplied by this plant. The Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y., will be enlarged to meet the greater demand in the eastern territory.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has recently perfected a portable pipe-thawing transformer of five-kilowatt capacity; also a choke coil to work in connection with standard fifteen and twenty-kilowatt lighting or power transformers, thus making a standard capacity transformer available for thawing purposes in winter. The company has some interesting printed matter describing this apparatus, which can be secured by addressing any of the district offices.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has printed a handsome catalogue descriptive of the Curtis steam turbine. The illustrations show some of the representative installations of these turbines, the nature of the installation being described in the titles. The first machine was put into commercial service in the power-house of the General Electric Company at Schenectady, N. Y., on October 1, 1902. Curtis turbines now in commercial service have a rated capacity of over 135,000 kilowatts and an overload capacity of over 202,500 kilowatts.

THE CHANDLER & TAYLOR COMPANY, Indianapolis, Ind., has recently closed a contract for three engines with the Michigan Agricultural College, Lansing, Mich. These engines are of the company's standard service enclosed self-oiling tube, two of 100-kilowatt, and one of fifty-kilowatt capacity. They will be direct-connected to Bullock generators. Two engines of the same type, one of 100-kilowatt capacity, and one of fifty-kilowatt capacity, have been ordered by the Sisters of Providence and Charitable Institutions, St. Mary's, Ind., and one by the N. Auth Provision Company, Washington, D. C.

THE ELECTRICAL TESTING LABORATORIES, New York city, has installed a machine for testing some of the mechanical properties of conductors. The rated capacity of this machine in the measurement of tensile strength is 15,000 pounds. This is sufficient to break a No. 0000 hard-drawn copper wire. By this addition to its equipment, which has been made in response to the demands of its clients, the company now has excellent facilities for all such tests of wires and cables as are ordinarily required in electrical practice. These comprise measurements of conductivity, insulation, resistance, dielectric strength, electrostatic capacity, tensile strength, elongation, elastic limit, etc.

THE CHICAGO & ALTON RAILWAY AND THE MOBILE & OHIO RAILWAY will run a solid train, leaving Chicago every Friday afternoon at two o'clock, and arriving at Mobile, Ala., Saturday afternoon, for a special Cuban service. The new steamer Prince George, of the Munson Line, will sail two hours after the arrival of the train, arriving at Havana harbor at daybreak Monday morning. Cuba, as a winter resort, is vying with California, and the demand for better service for Chicagoans and the adjacent territory has reached such proportions that already there is assurance that the train will be a success.

THE LYON METALLIC MANUFACTURING COMPANY, 14-20 South Ann street, Chicago, Ill., is calling attention to the Lyon steel racks for industrial equipments of every kind. On a neat advertising card there is illustrated a view of a stockroom equipped with these racks. This room contains over 100,000 running feet of shelving. The company using this equipment has reduced the fire risk, enforced system, reduced the labor cost, and increased floor space. The Lyon Metallic Manufacturing Company has a well-equipped jobbing department, and can quote on all kinds of sheet metal, copper, tin and galvanized ironwork.

THE GOULD STORAGE BATTERY COMPANY, New York city, in bulletin No. 6 describes and illustrates a regulating battery in connection with a combined railway and lighting plant. This is a description of the installation for the Edison Electric Illuminating Company, of Topeka, Kan. The installation consists of 280 elements, type S-617, each having a capacity of 640 amperes for one hour; and a booster set which controls the operation of the battery so that the generator load does not vary even under extreme conditions more than two and one-half per cent from any mean value for which the booster may be adjusted.

THE L. B. ALLEN COMPANY, INCORPORATED, 1335 Columbia avenue, Chicago, Ill., with New York offices at 97 Warren street, manufacturer of the Allen soldering stick, soldering paste, salts and commutator lubricant, reports a materially increased demand for its products during the present season. The marked success of this company with this line of specialties is interesting, in view of the fact that it may be almost wholly traced to good advertising. This company realizes the value of well-prepared "copy," and it is due to the intelligence with which this has been done, both in its journal and circular advertising, that it has been able to accomplish such results through advertising.

WILLIAM JESSOP & SONS, LIMITED, 91 John street, New York city, has issued a small book on Jessop's high grade tool steel. In it is given interesting information as to how this steel is made. The pages devoted to the "Hardening and Tempering of Jessop's Tool and Die Steel" will be of interest to those who are not generally informed as to the process required for accomplishing the best results. The character of Jessop's "Ark" high-speed steel is discussed, which is a steel especially produced for lathe tools requiring a cutting edge that will stand the highest rate of speed. Various tables of stock sizes of the different Jessop steels are given, which form excellent reference matter to one interested. In addition the company makes special annealed die blocks and rings, and forgings of irregular shape as well as annealed cutter blanks. The Jessop company operates a factory at Washington, Pa., for the manufacture of circular saw plates, cross-cut plates and long-saw plates and short saw steel. Branch offices and agencies are maintained in nearly all large cities.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., has issued a pamphlet devoted to "The 1906 Thawer for Thawing Frozen Pipes." The purpose of this publication is to show the practicability of thawing frozen pipes by means of electricity, as well as to demonstrate the economy of the method. As the result of a long series of tests this company obtained considerable original data, and ultimately developed an apparatus for the work which was used throughout the seasons of 1904-1905. A further evolution has been accomplished in the 1906 type, which is claimed to be the best ever manufactured for doing this class of work, inasmuch as it is said to be extremely simple, permitting speed and safety in operation and perfect control of the necessarily heavy current employed, and lastly, the equipment is marketed at a moderate price. This 1906 thawer consists of a transformer which takes a small current from the line at approximately 1,100 or 2,200 volts, and delivers to the pipe a very heavy current of low voltage. The transformer is equipped with primary fuse blocks, a controller device for adjusting the current, a heat indicator and a heavy secondary switch.